

APPENDIX III
AIR MODELING SUMMARY

Air Pollution

An important component of environmental risk in the City of Chester is air pollution. Air pollutants are airborne contaminants that can be particulate (including smoke or dust particles and fine liquid mists) or gaseous in form. The primary route of exposure to these pollutants is through inhalation.

AIR QUALITY MONITORING

Pursuant to federal regulations (40 CFR 58), the Pennsylvania Department of Environmental Resources (PADER) maintains a statewide network of air quality monitors in order to determine compliance with health-based National Ambient Air Quality Standards (NAAQS). NAAQS exist for the six criteria pollutants: carbon monoxide (CO), lead, nitrogen dioxide (NO₂), ozone¹, particulate matter (expressed as particulate smaller than 10 micrometers in diameter, PM-10), and sulfur dioxide (SO₂).

In Chester, PADER samples the air for five of these pollutants (all except CO) at its monitoring station on Philadelphia Gas Works (PGW) property at Front & Norris Streets. Table 1 summarizes air quality with respect to the five pollutants monitored at the PGW site.

Note that monitored concentrations for ozone exceed national standards. More than the other pollutants for which NAAQS exist, ozone exceedances are caused by the release of other substances (especially volatile organic compounds, nitrogen oxides, and carbon monoxide) that cause the formation of ozone downwind, sometimes after travel distances of hundreds of miles. Tens of million of Americans, including most citizens of the northeast corridor in a contiguous area that stretches from Virginia to Maine, live in areas that violate the ozone NAAQS. The Clean Air Act, as amended in 1990, has established a number of requirements for areas exceeding the ozone NAAQS in an effort to reduce emissions of ozone precursors and meet the NAAQS. See EPA's Ozone-- Good Up High, Bad Nearby (EPA-451/F-93-010) and Smog: Its Nature and Effects (Inside EPA, October 1987), for more information.

Although enforceable ambient standards exist for only six criteria pollutants, many other contaminants threaten human health. Because routine monitoring is limited to the criteria

¹In this context, we are discussing ground-level (tropospheric) ozone, which can irritate and damage the lungs and other sensitive tissue. Ozone in the upper atmosphere (the stratosphere) helps shield the earth from certain ultra-violet radiation emitted by the sun. This "good" ozone is formed naturally and independently from ground-level ozone pollution.

pollutants and this monitoring may not be representative of the entire City of Chester, air quality modeling has been used to estimate potential inhalation risks to Chester residents. This modeling is described below.

MODELING OF POINT AND AREA SOURCES

Air quality models are mathematical representations of the way contaminants move in the atmosphere. Models are useful in characterizing air pollution in the City of Chester for a number of reasons. First, the number of monitors and the location of suitable monitoring sites in the city are finite, while a model can accomplish estimates of air quality impacts at any location. Second, while it is impractical to monitor for every conceivable contaminant that may be in the air, modeling can be used to estimate concentrations of most non-reactive contaminants for which an emission rate can be estimated. Finally, monitoring can only provide information regarding the pollutants being monitored, at the time and location the monitoring is performed. The information gathered during short-term monitoring studies is not always representative of typical conditions or long-term averages, nor can it generally be used to predict the effectiveness of control strategies.

In order to estimate ambient concentrations, air quality models require data that describes the emissions, the meteorology, and the terrain of the area to be modeled. For the Chester Study, meteorological data collected at Philadelphia International Airport and terrain data from the United States Geological Survey were used. The emissions inventory was developed by using inventories of criteria air pollutants and ozone precursors, maintained by the states of Pennsylvania, New Jersey, and Delaware (pursuant to Title I of the Clean Air), and limited air toxics inventories (Toxics Release Inventory) maintained by EPA (pursuant to Title III of the Clean Air Act) to identify as many potential sources of air pollution as possible. Then, emissions of specific air contaminants were estimated using information found in a variety of references. All of the emission sources and methods used to estimate the emission rates are found in the report Air Toxic Emission Inventory and Dispersion Modeling for Chester, Pennsylvania, prepared by Pacific Environmental Services (PES) under contract to EPA.

Figure 1 summarizes the emissions inventories in terms of emissions of volatile organic compounds (VOCs) and particulate (PM) from point and area sources. Point sources are emissions from stacks and vents that are handled as discrete sources in the modeling. Area sources are emissions such as consumer solvent use that occur reasonably uniformly over some geographical area. Point, area, and mobile source inventories are discussed in detail in the report Air Toxic Emission Inventory and Dispersion Modeling for Chester, Pennsylvania,

Once emission rates were estimated for the 700-odd pollutants that were identified, the model was run once for each pollutant to generate estimates of annual average concentrations at locations throughout the City of Chester. Shorter-term averages were estimated for some of the criteria pollutants. The results of this modeling are found in the report Air Toxic Emission Inventory and Dispersion Modeling for Chester, Pennsylvania.²

MODELING OF MOBILE SOURCES

While emissions from mobile sources were included with the area source inventory, a special modeling study was made of emissions from vehicular traffic on Second Street, between Thurlow and Montgomery Streets. Pennsylvania Department of Transportation traffic counts and estimates from the Delaware County Resource Recovery Facility solid waste permit application were used, along with the MOBILE and PART5 emissions of VOCs and particulate, respectively. Then, the CAL3QHC model, which is specifically designed to accomplish estimates of short-term average pollutant concentrations from roadway emissions, and the ISC model were used to estimate ambient concentrations of VOC and particulate. Speciation profiles were applied to the particulate and VOC concentrations to produce contaminant-specific concentration estimates. The methodology and results of this modeling are documented in Appendix J of the report Air Toxic Emission Inventory and Dispersion Modeling for Chester, Pennsylvania.

UNCERTAINTY

While the air quality analysis provides a reasonable estimate of airborne the contaminant levels in Chester, there are a variety of sources of uncertainty associated with the study, most notably:

- Incompleteness of the emissions inventory;
- Unrepresentative and/or inaccurate the toxic profiles;
- Errors in the source emission estimates;
- Errors/omissions in the emissions source characteristics

²The modeling of ozone, which requires emissions and meteorological data representing many thousands of square miles, was beyond the scope of this study. Because ozone is formed and transported over large distances, ground-level concentrations tend not to vary substantially from location to location. For the purpose of the current study, the monitored ozone concentrations will suffice to characterize current conditions.

(e.g., stack exit velocity, building heights);

- Uncertainties in the dispersion model algorithms; and
- Representativeness of the meteorological data.

The problem of the incompleteness of the source inventory is troubling as it is impossible to account for non-reported emissions in a rigorous, representative way.

The problem of unrepresentative or inaccurate toxic profiles results, in part, from the use of very broad source categories. For many of the VOC sources, especially those related to solvent use and chemical and petrochemical manufacture, the existing inventories are not specific in describing the industrial activities that are producing emissions. (For example, "chemical manufacturing-- average" and "organic solvent use-- general" were not uncommon).

Reliance on the SPECIATE database for many of the profiles of VOC emissions is also an important source of uncertainty. SPECIATE was developed for use in ozone modeling and, consequently, has drawbacks for use in the Chester emissions inventory.

First, because ozone is a secondary pollutant (formed by the photo-oxidation of VOCs and other precursor emissions), the ozone domains are quite large and concentration gradients are correspondingly small. Correctly estimating the constituent chemical species of VOC emissions from any single emission point (even a large one) is much less important than the correctness of large geographical portions of the inventory as a whole. For these types of inventories, the speciation of source categories only needs to be accurate on average for a fairly broad region. (In statistical terms, the estimate of the average that is important, but the deviation of any given source from the average is inconsequential.) In contrast, the modeling for Chester, did was quite local, and if a large emission points source's profile deviates greatly from the estimate from the SPECIATE database, then estimates of local pollutant concentrations will be effected.

Also, in the development of the SPECIATE database, emphasis was placed on reactivity with respect to the potential ozone formation-- toxicity was a secondary concern at best. There may be instances where chemical is in a SPECIATE profile is used to represent a class of compounds of similar reactivity. While the compounds may have similar reactivity, they may not have similar toxicities.

Uncertainty is discussed in more detail in Section 5 of Air Toxic Emission Inventory and Dispersion Modeling for Chester, Pennsylvania.

Table 1

Pollutant	NAAQS ($\mu\text{g}/\text{m}^3$ unless indicated)	1993 Monitored Concentration
O ₃ , 1-hr(a)	120 ppb	123 ppb
PM-10, annual(b)	50	27
PM-10, 24-hr(a)	150	60
Pb, cal. quarter(c)	1.5	0.04
SO ₂ , annual(c)	80	24
SO ₂ , 24-hour(d)	365	69
SO ₂ , 3-hour(d)	1300	121
NO ₂ , annual(c)	100	39
CO, 8-hour(d)	10	not monitored
CO, 1-hour(d)	40	not monitored

Data shown are from 1993, the most recent year for which complete data are available.

- (a) Standard is attained when the expected number of exceedances per year is less than or equal to 1. (Reported monitored concentration is the second-high.)
- (b) Standard is attained when the expected annual arithmetic mean is less than or equal to 50.
- (c) Never to be exceeded. (Reported monitored concentration is the average of one quarter of available data from 1994.)
- (d) Not to be exceeded more than once per year. (Reported monitored concentration is the second-high.)

Figure 1: Modeling Emissions Inventory

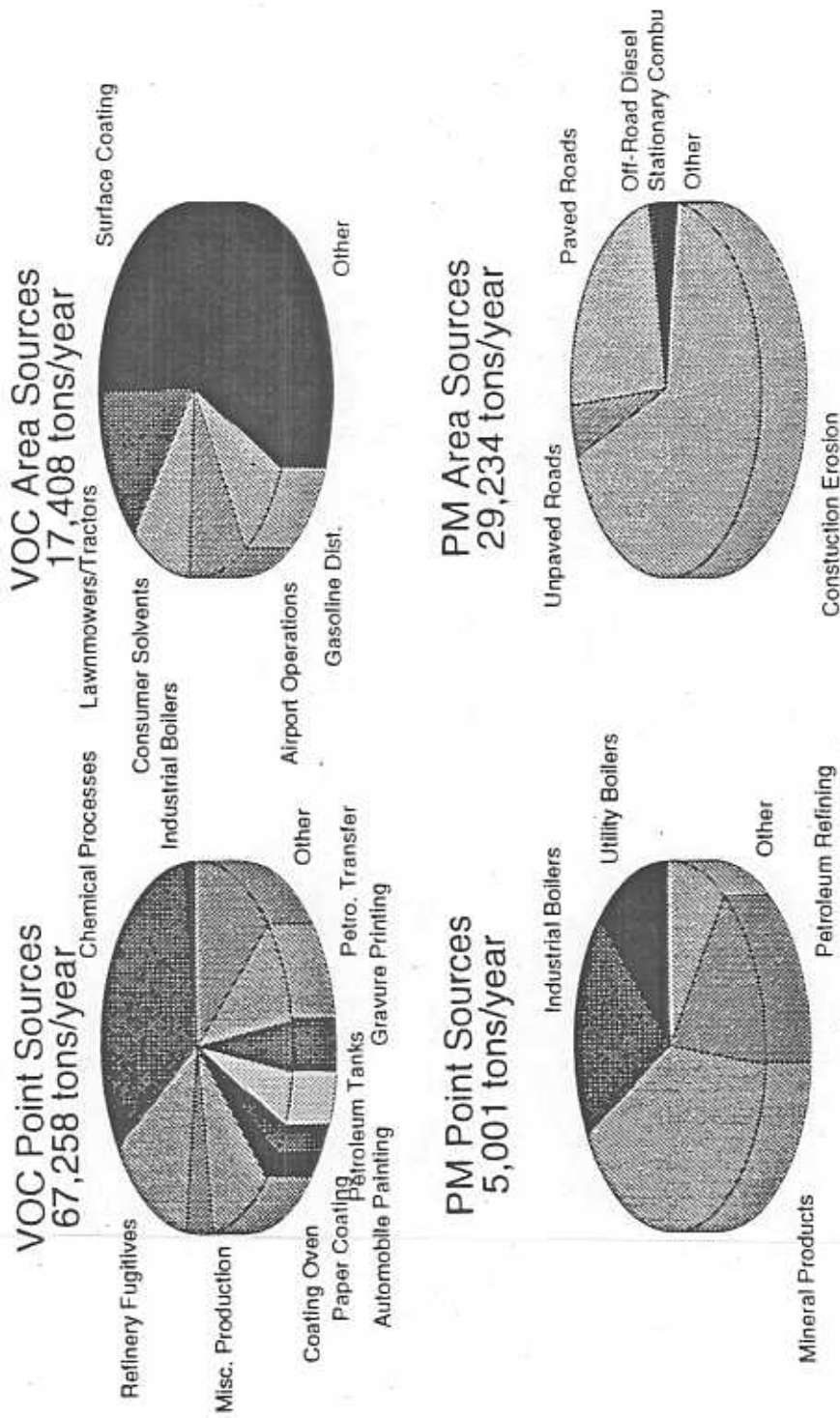


Figure 1 displays the major emission sources from the point and area source modeling inventories. (Mobile sources are excluded.) It should be noted that, as a modeling inventory, this inventory is biased toward larger sources (especially sources outside of Chester) because only those sources which were believed to have the potential to significantly impact Chester were included. For example, a 1,000 ton/year source in Wilmington would be included in the inventory while a 10 ton/year source may not.

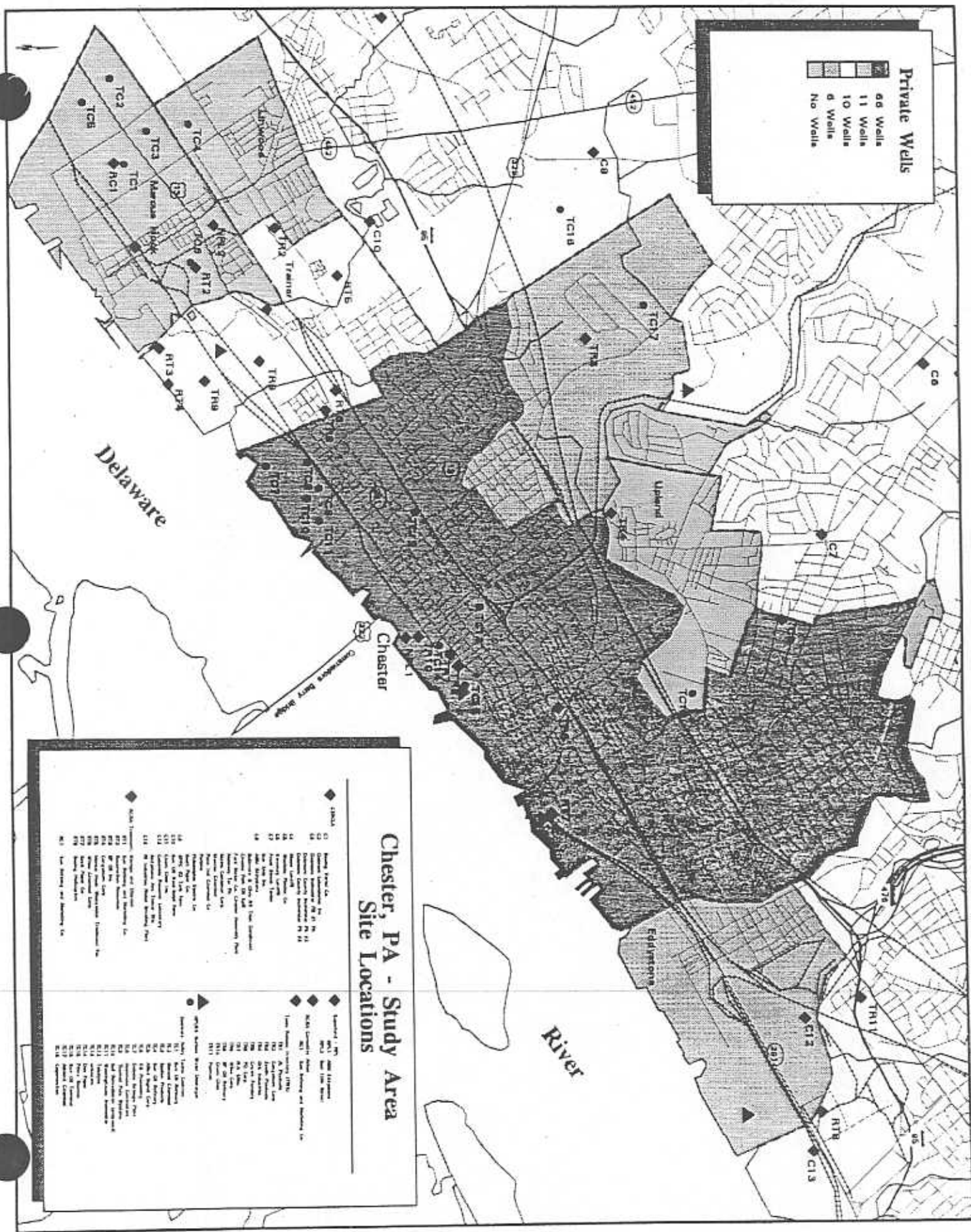


Figure 4-1

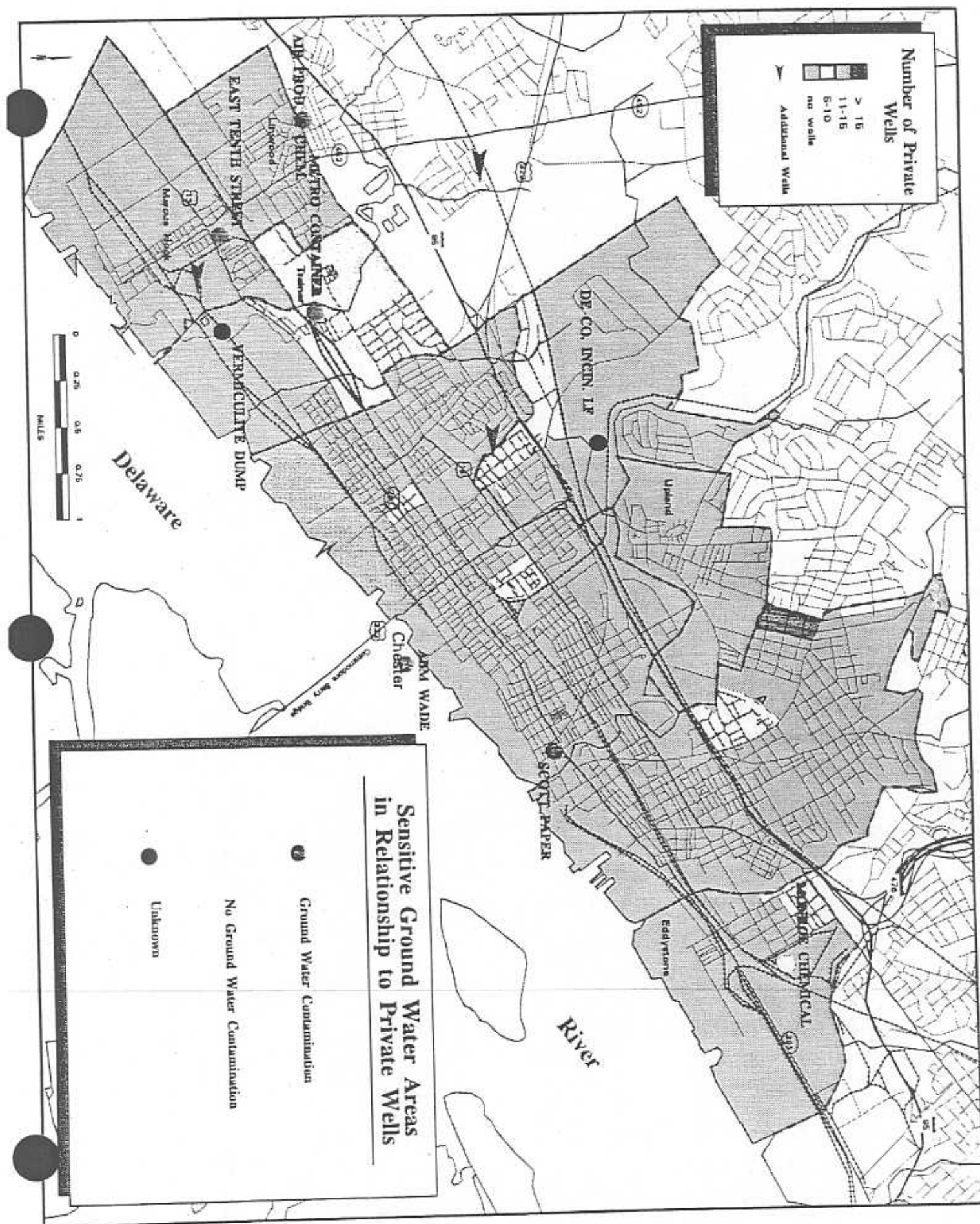
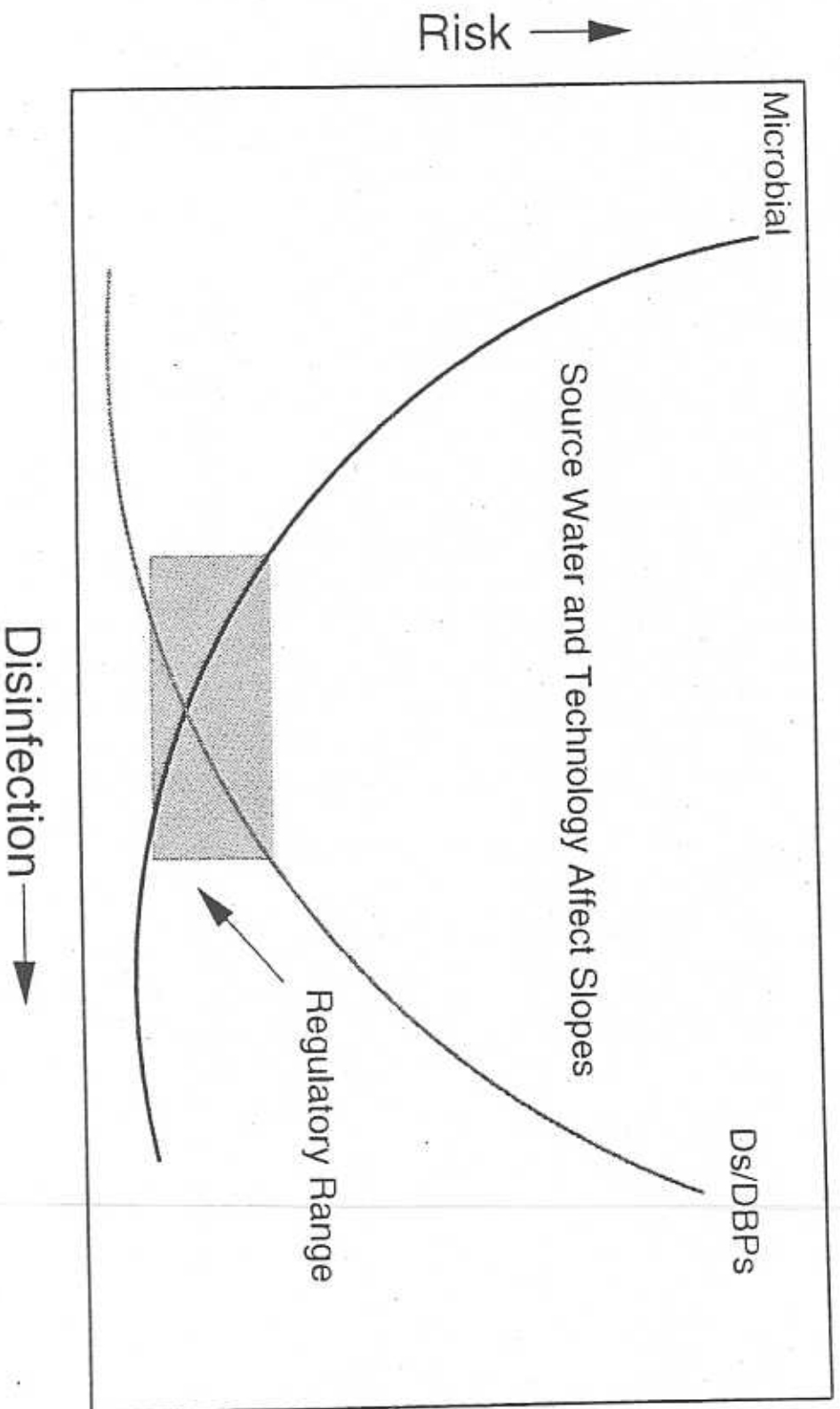


Figure 4-3

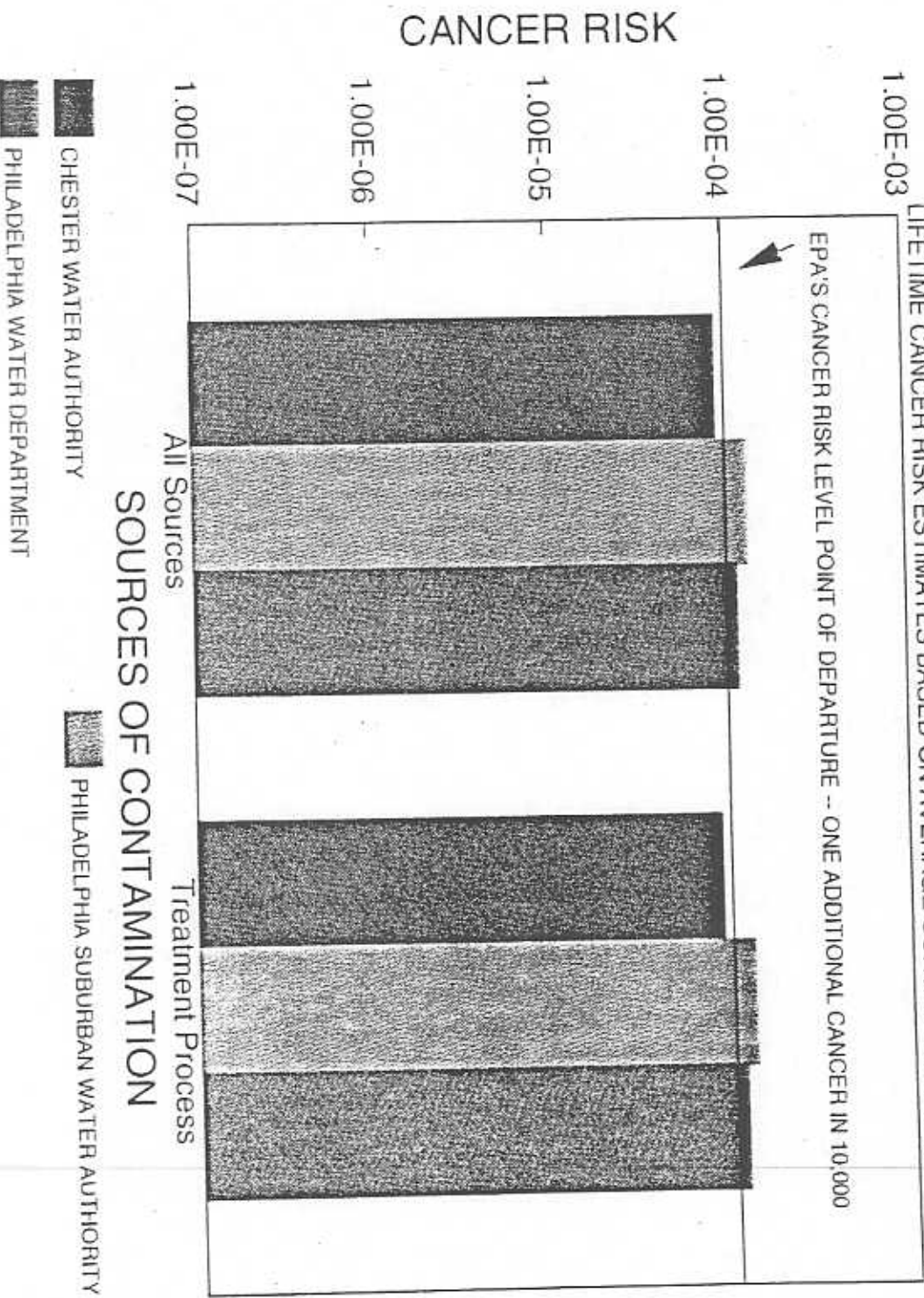
CHESTER RISK PROJECT

FIGURE 4-4 - RISK TRADE-OFFS
DISINFECTION BYPRODUCTS VS. MICROBIAL GROWTH



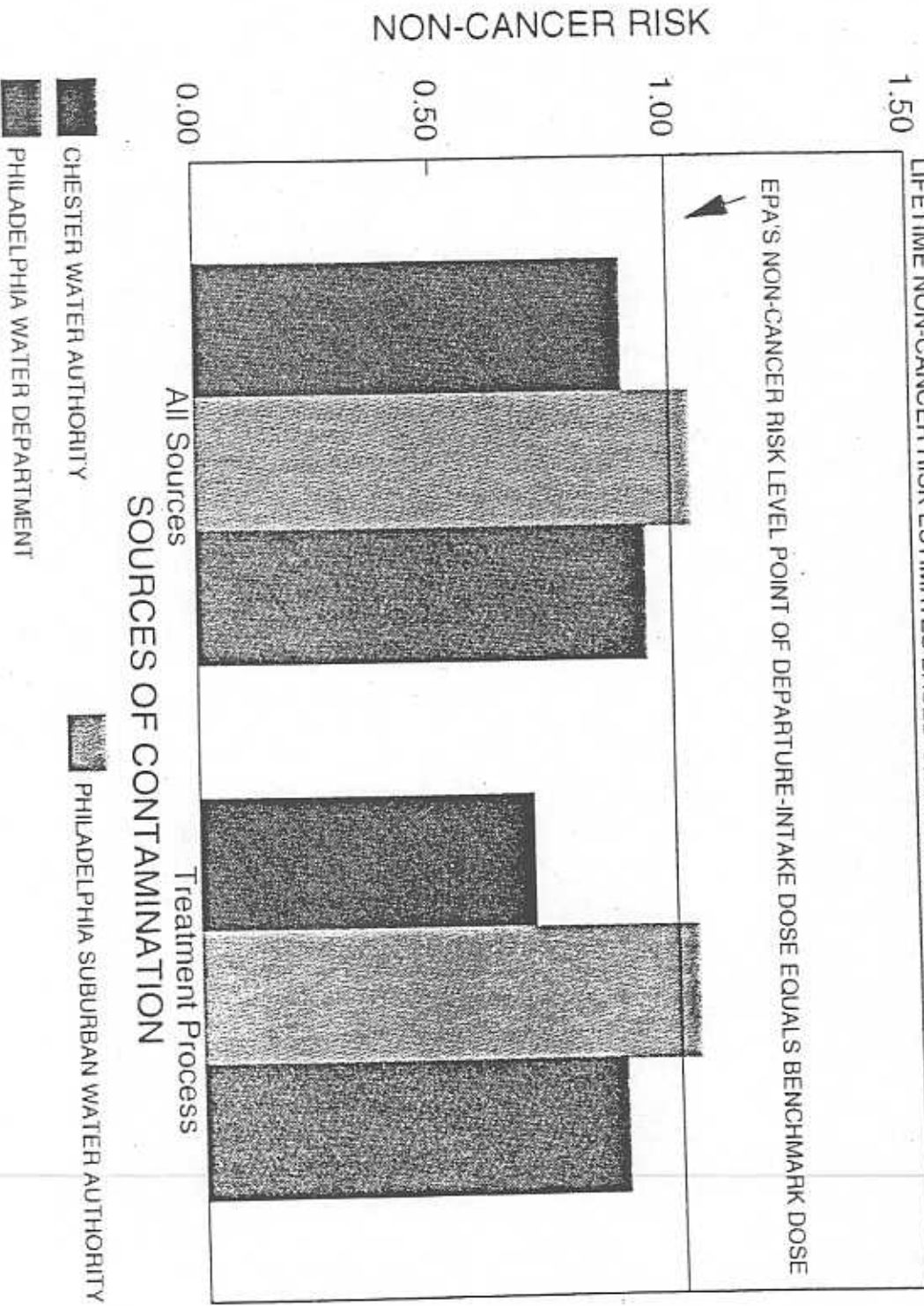
CHESTER RISK PROJECT

FIGURE 4-5 - COMPARISON OF RISK LEVELS FOR FINISHED WATER SUPPLIES
LIFETIME CANCER RISK ESTIMATES BASED ON AVERAGE CONTAMINANT LEVELS IN 1993



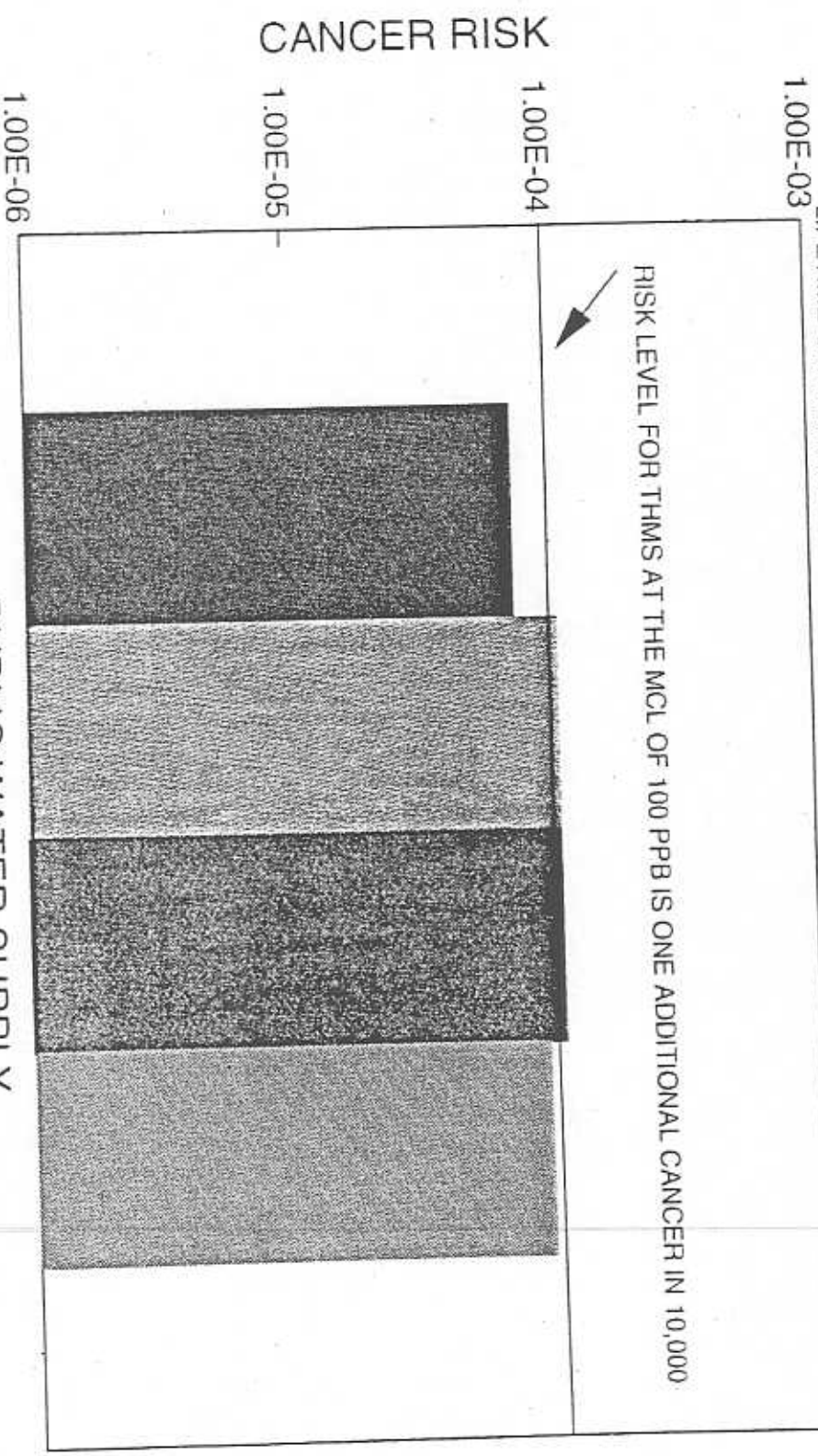
CHESTER RISK PROJECT

FIGURE 4-6 - COMPARISON OF RISK LEVELS FOR FINISHED WATER SUPPLIES
LIFETIME NON-CANCER RISK ESTIMATES BASED ON AVERAGE CONTAMINANT LEVELS IN 1993



CHESTER RISK PROJECT

FIGURE 4-7 - COMPARISON OF RISK LEVELS FOR FINISHED WATER SUPPLIES
 LIFETIME CANCER RISK ESTIMATES FOR THMS BASED ON AVERAGE LEVELS DETECTED IN 1993



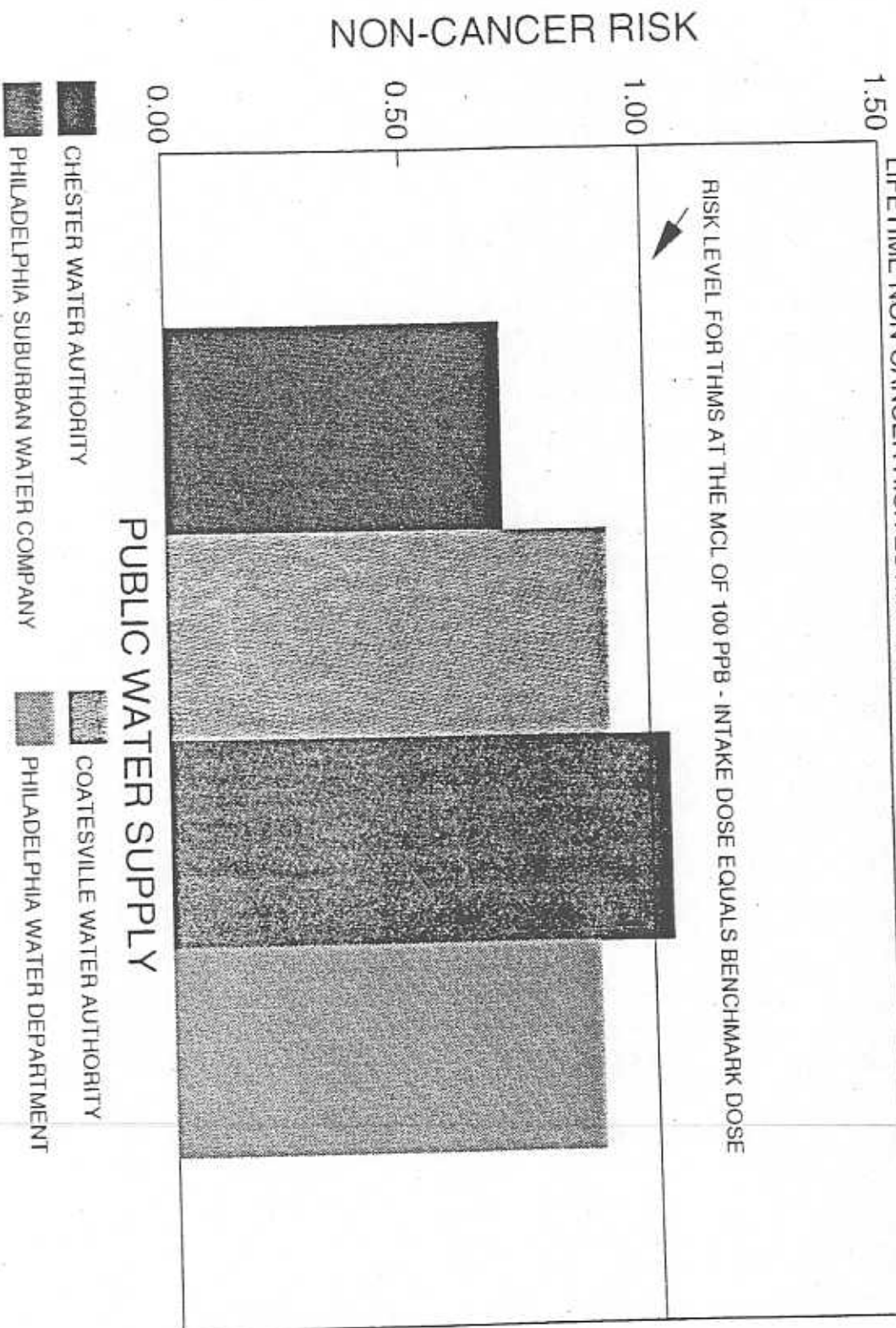
PUBLIC WATER SUPPLY

- CHESTER WATER AUTHORITY
- PHILADELPHIA SUBURBAN WATER COMPANY
- COATESVILLE WATER AUTHORITY
- PHILADELPHIA WATER DEPARTMENT

THMS-TRIHALOMETHANES ARE PRODUCED DURING THE CHLORINATION PROCESS
 MCL-MAXIMUM CONTAMINANT LEVEL: PPB-PARTS PER BILLION

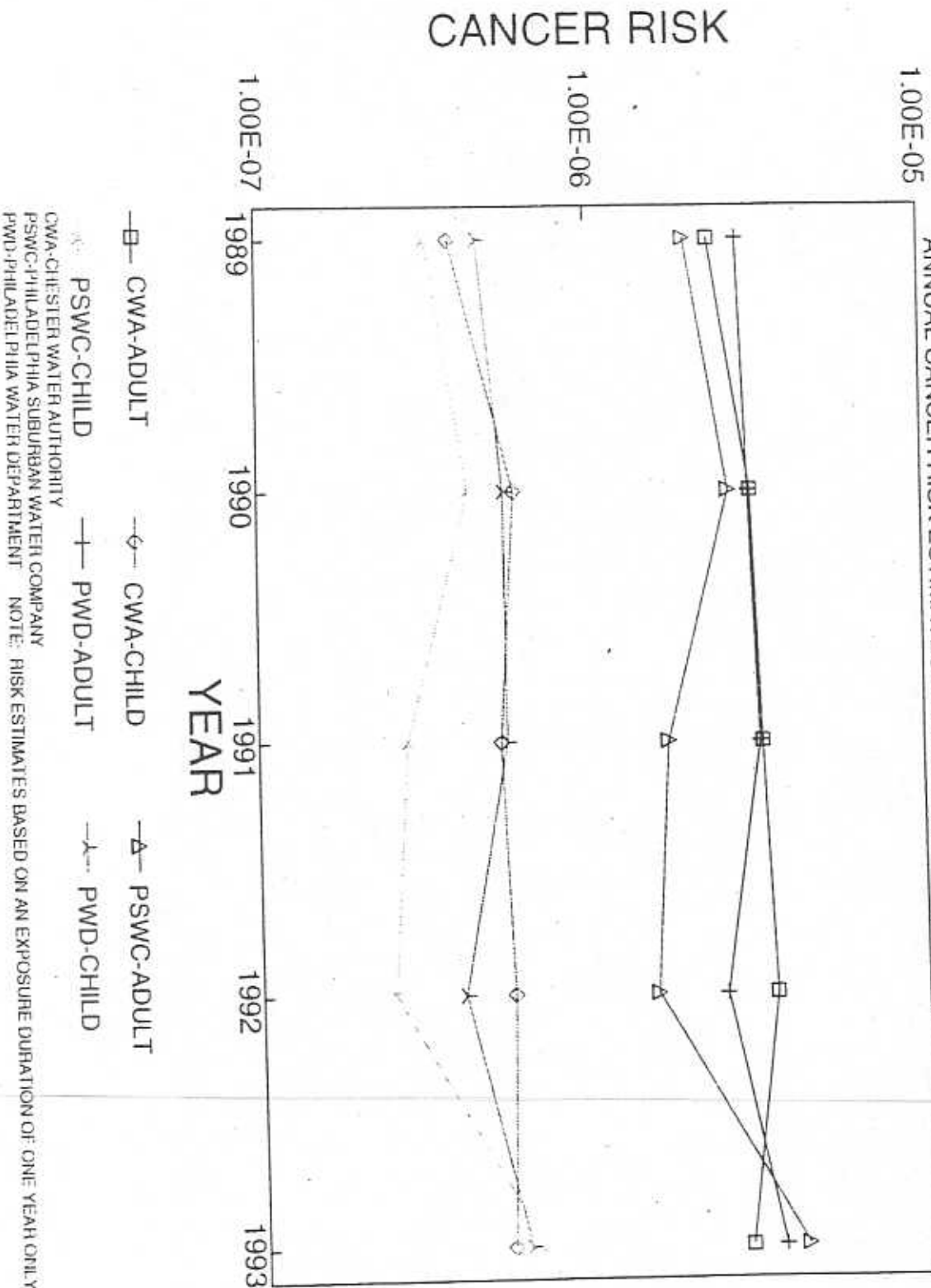
CHESTER RISK PROJECT

FIGURE 4-8 - COMPARISON OF RISK LEVELS FOR FINISHED WATER SUPPLIES
LIFETIME NON-CANCER RISK ESTIMATES FOR THMS IN 1993 BASED ON AVERAGE LEVELS



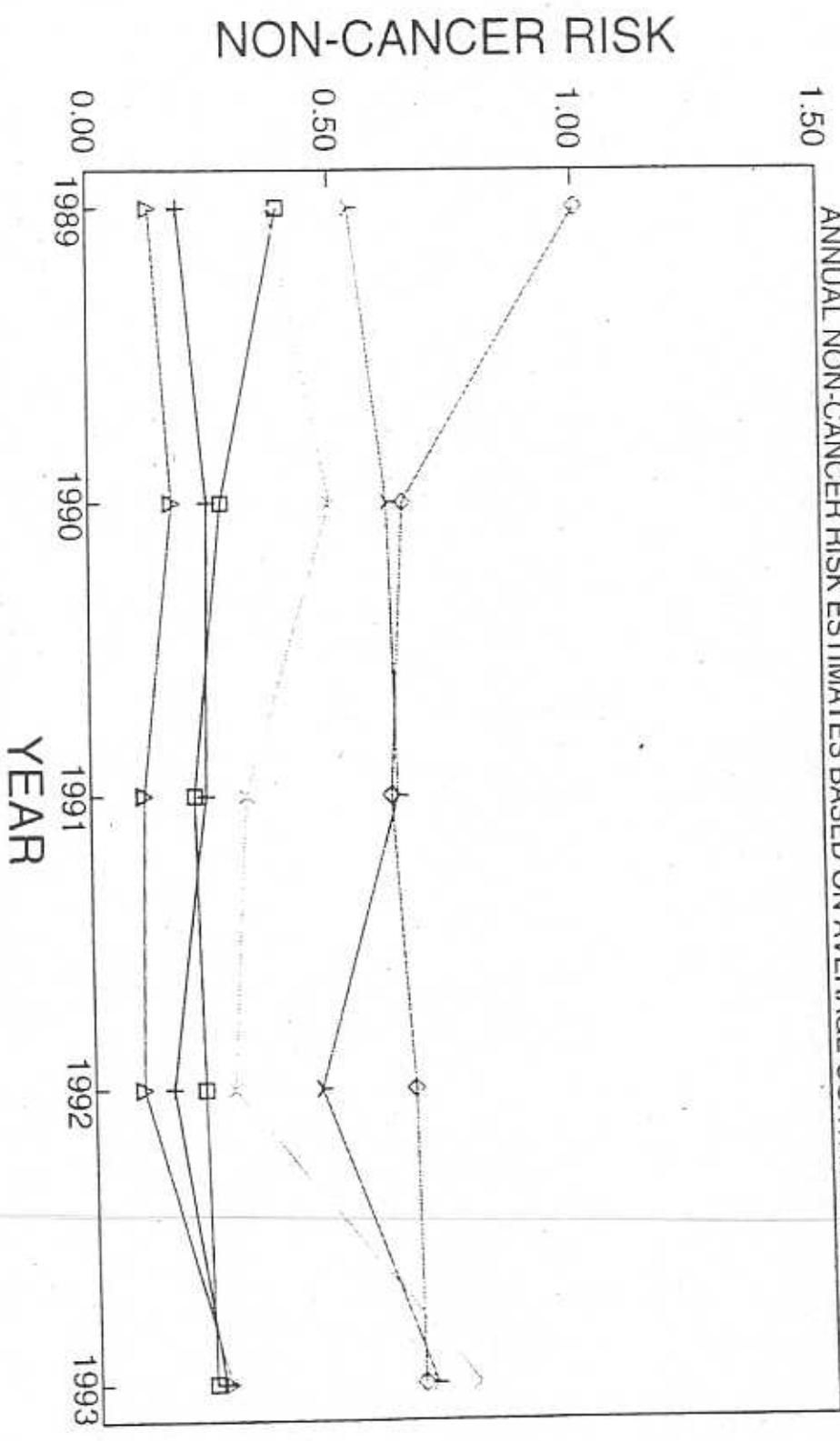
CHESTER RISK PROJECT

FIGURE 4-9 - COMPARISON OF RISK LEVELS FOR FINISHED WATER SUPPLIES
ANNUAL CANCER RISK ESTIMATES BASED ON AVERAGE CONTAMINANT LEVELS



CHESTER RISK PROJECT

FIGURE 4-10 - COMPARISON OF RISK LEVELS FOR FINISHED WATER SUPPLIES
ANNUAL NON-CANCER RISK ESTIMATES BASED ON AVERAGE CONTAMINANT LEVELS



—□— CWA-ADULT —◇— CWA-CHILD —△— PSWC-ADULT
 —+— PSWC-CHILD —+— PWD-ADULT —+— PWD-CHILD
 CWA-CHESTER WATER AUTHORITY
 PSWC-PHILADELPHIA SUBURBAN WATER COMPANY
 PWD-PHILADELPHIA WATER DEPARTMENT NOTE: RISK ESTIMATES BASED ON AN EXPOSURE DURATION OF ONE YEAR ONLY

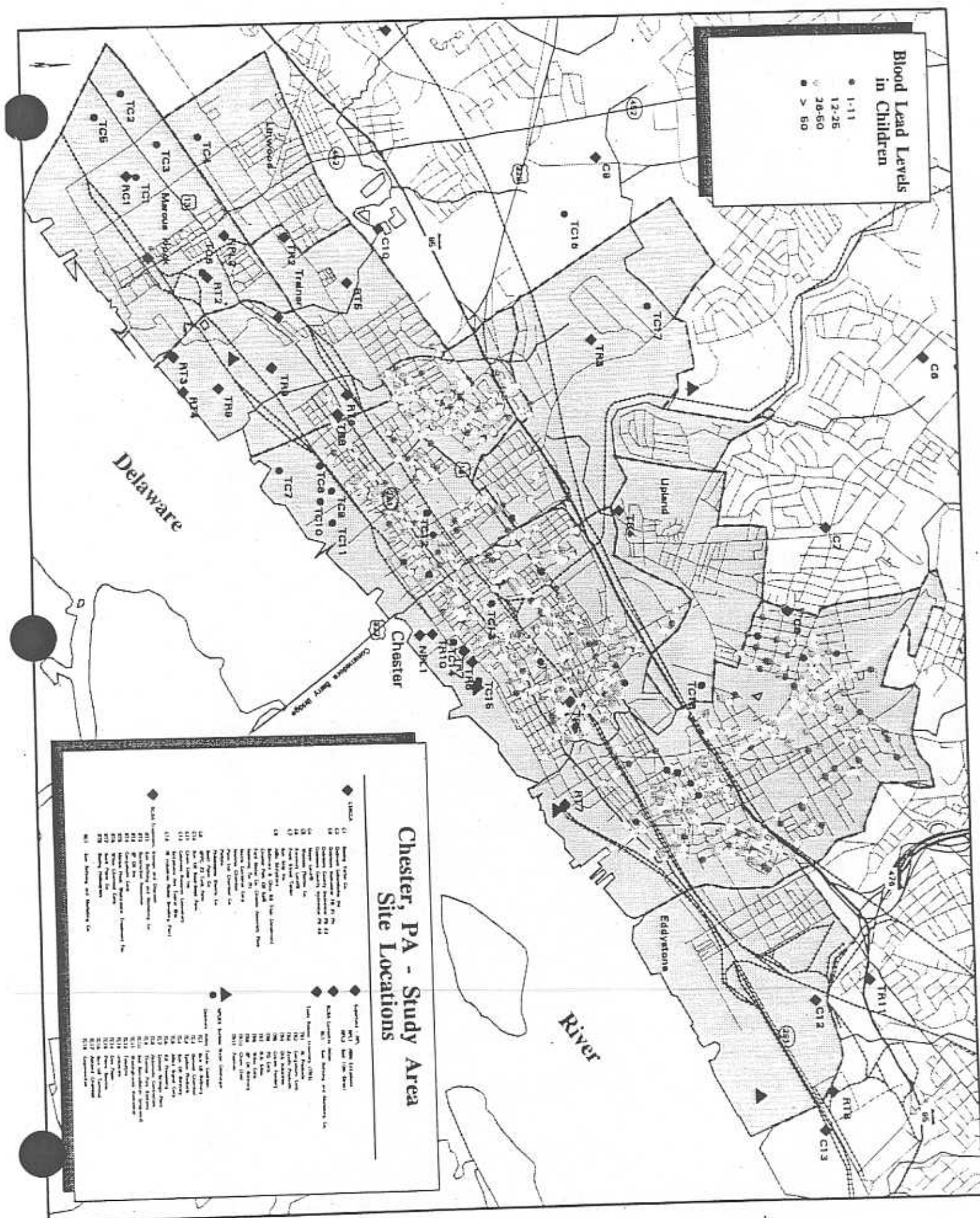


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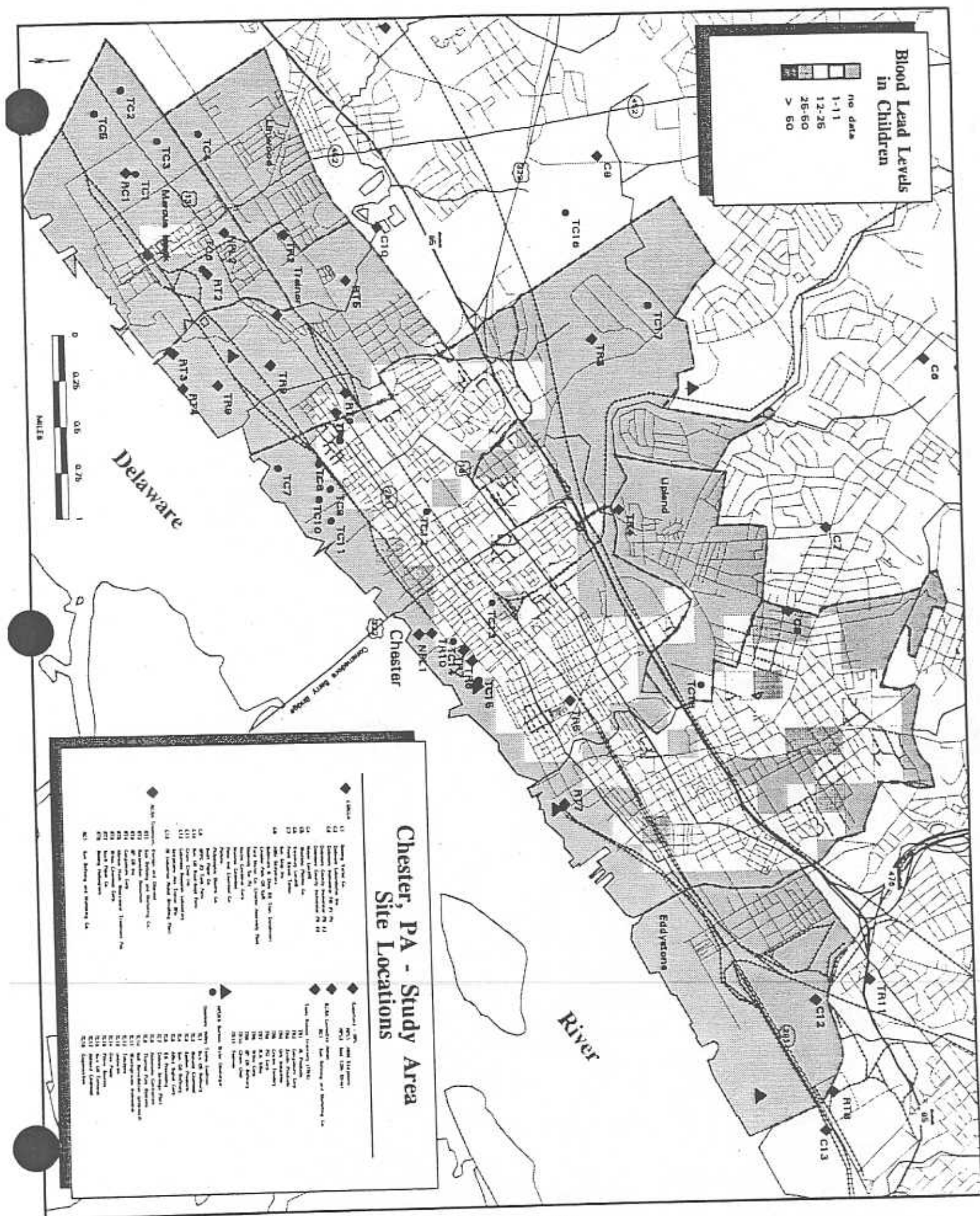


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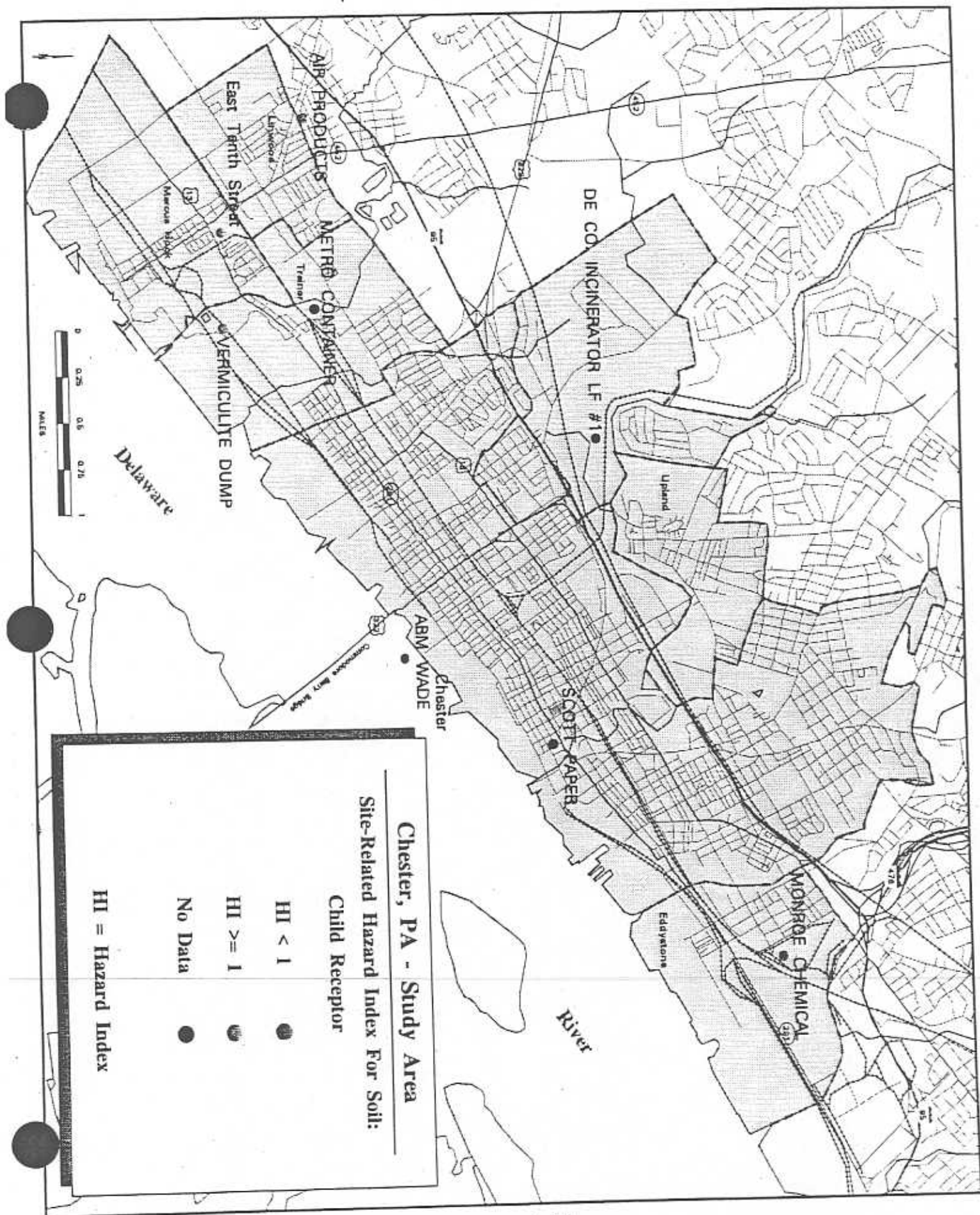


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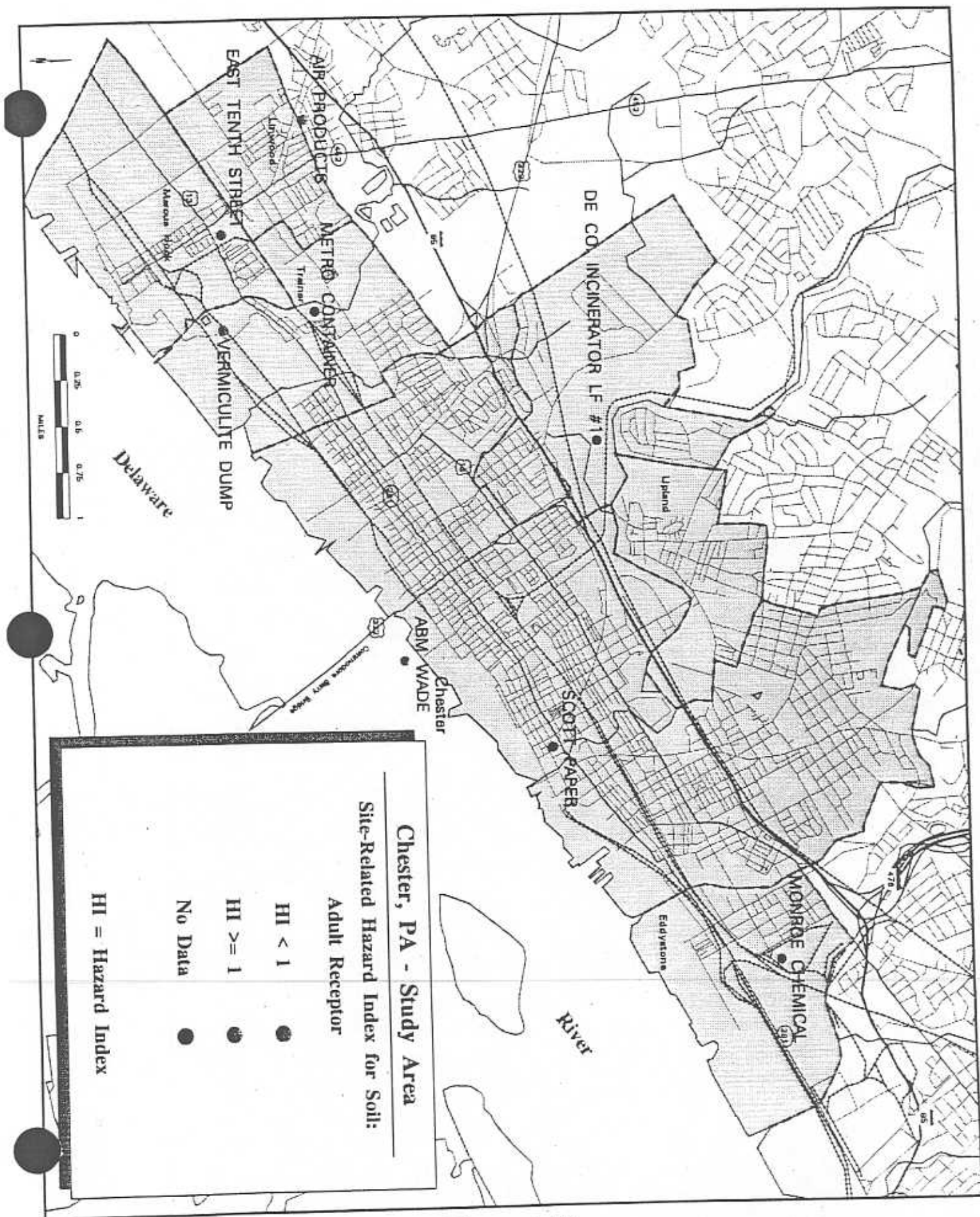


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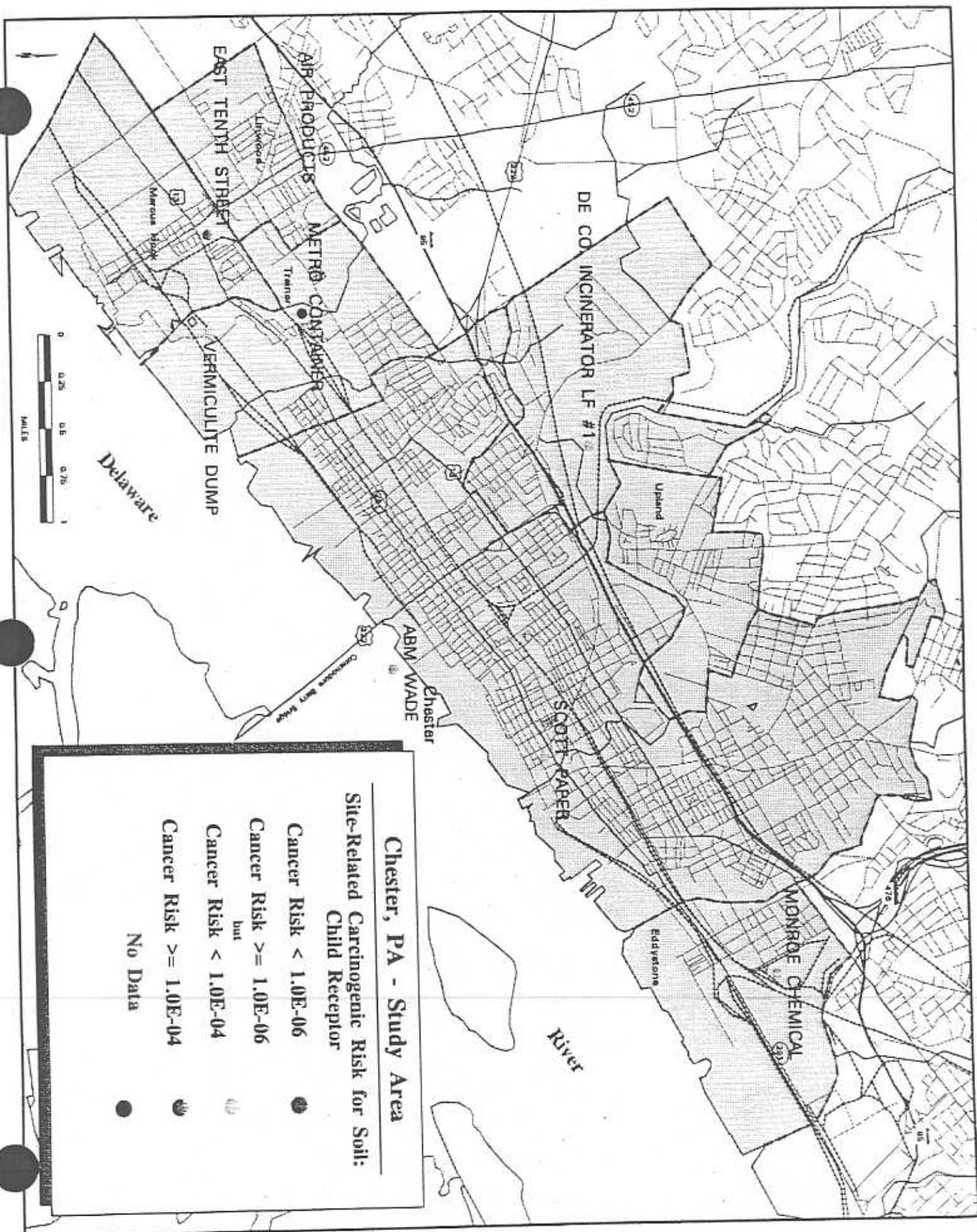


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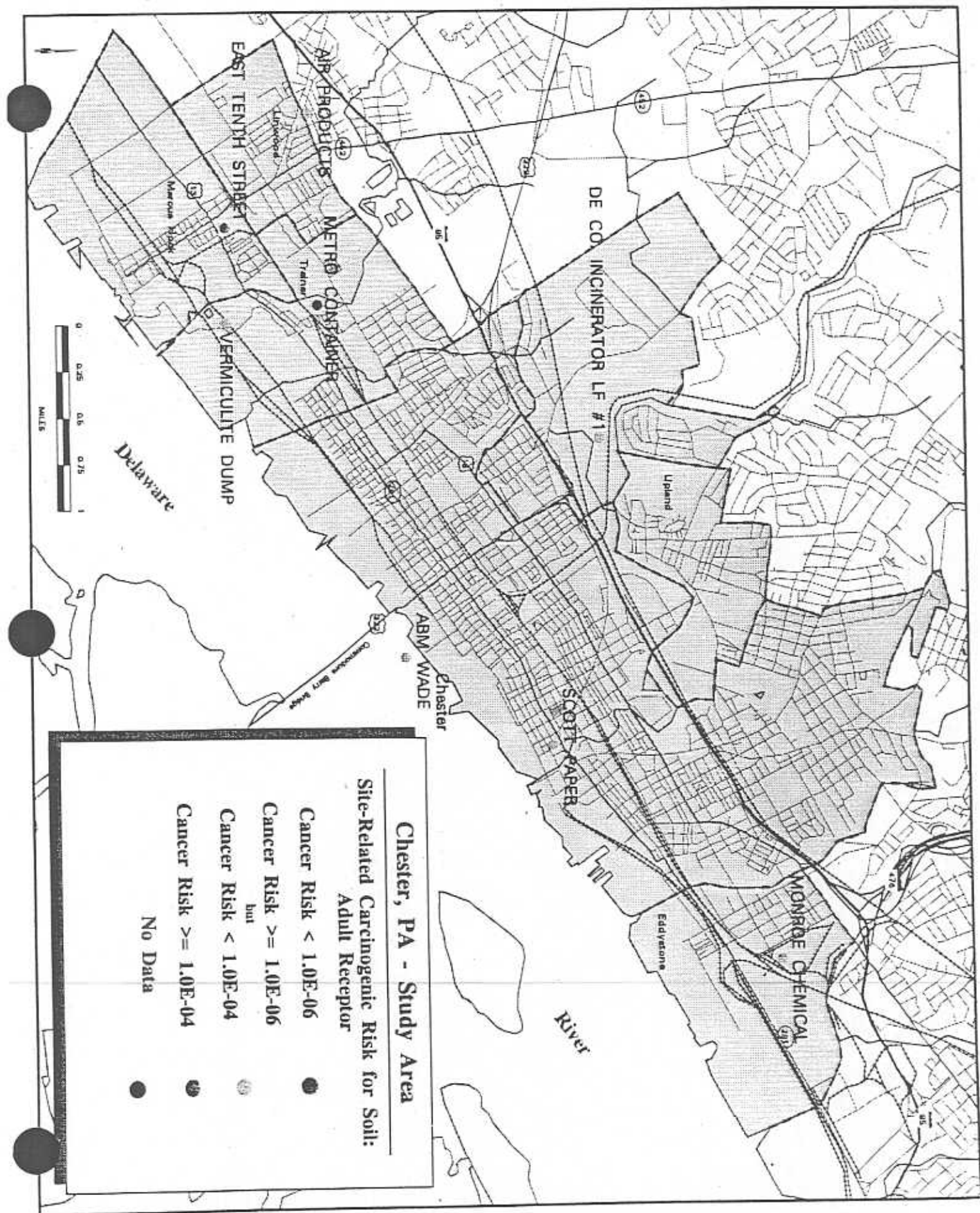


Figure 4-21

Chester Study Area

STORET Stations

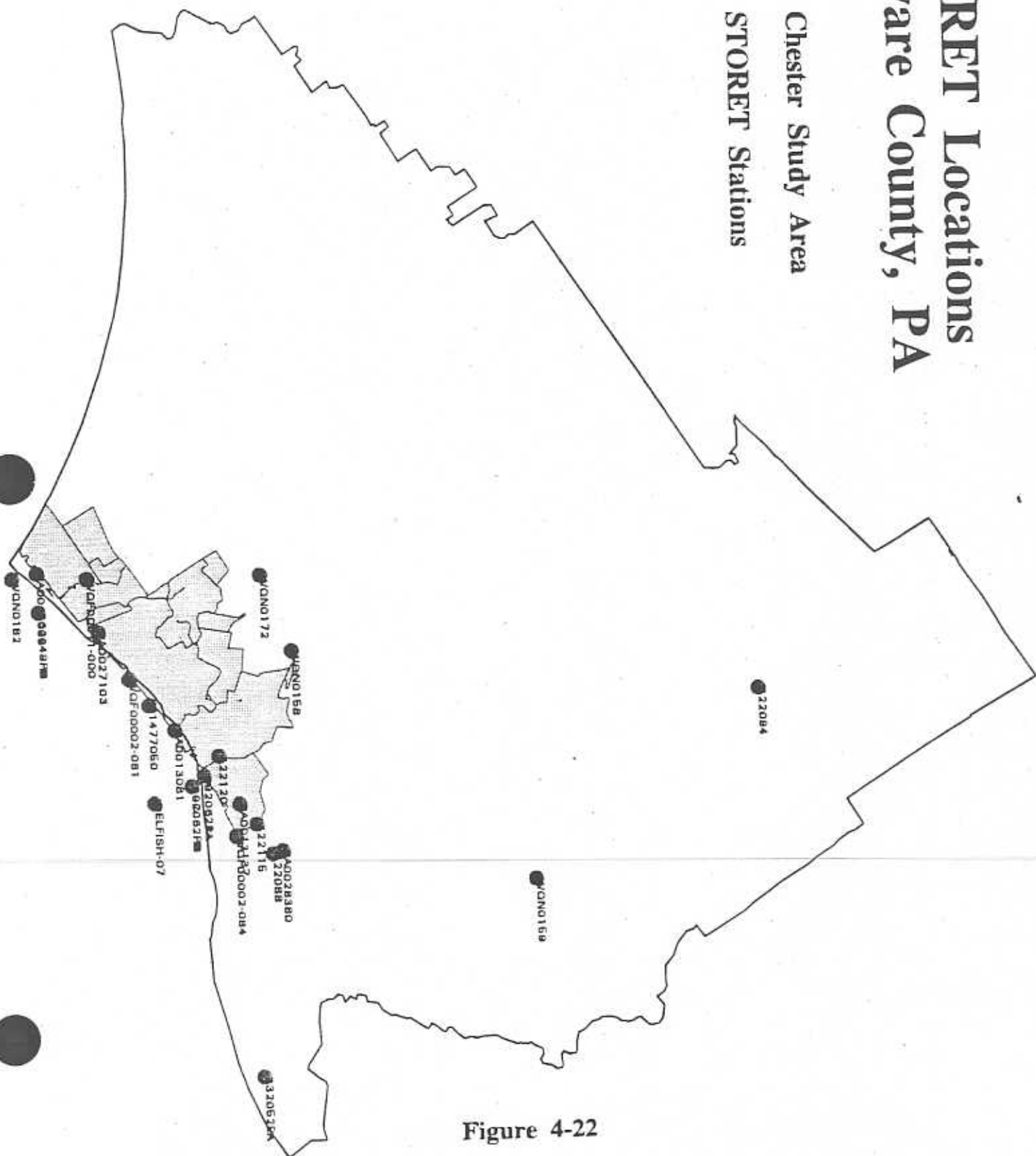


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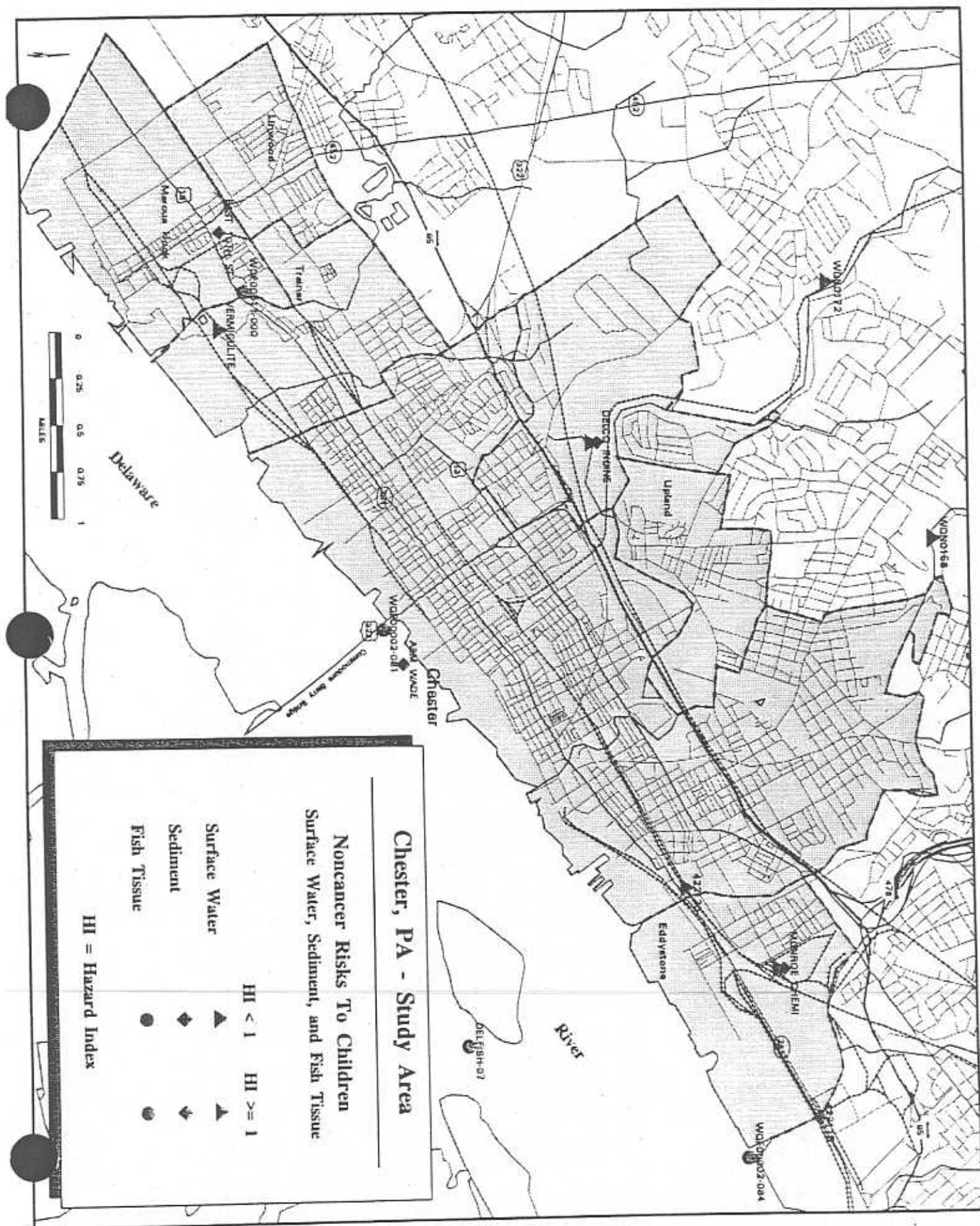


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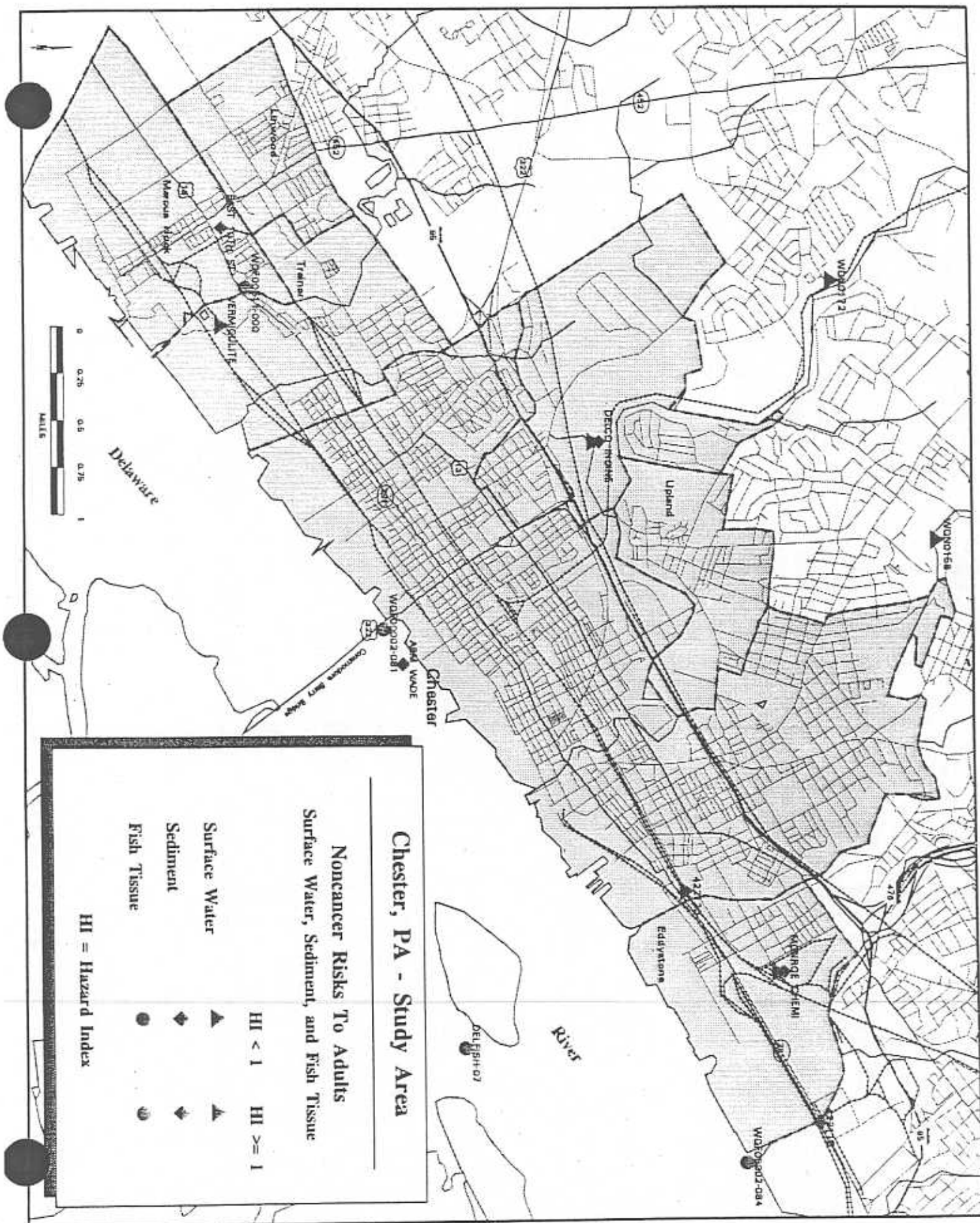
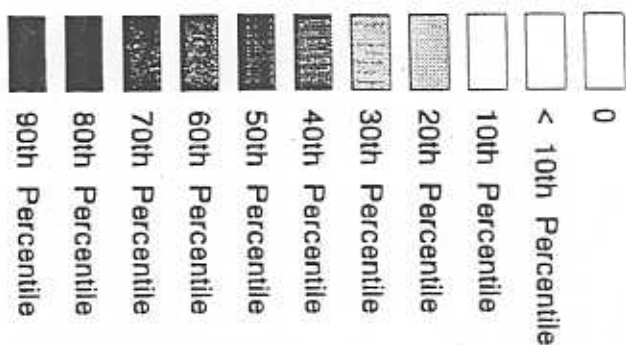


Figure 4-25

Chronic Index: EPA Region III On-Site Releases



EPA Region III
Air, Radiation, & Toxic Division
Dr. Debra L. Forman



Scale 1 : 3308410

Aggregated Grid:
6 x 6 Mile Blocks

Source: Toxic Release Inventory Data for 1988
1:100,000 USGS Digital File
Prepared by: Linda S. Anderson
EPA Region III Geographic Information Center
Date: April 16, 1994

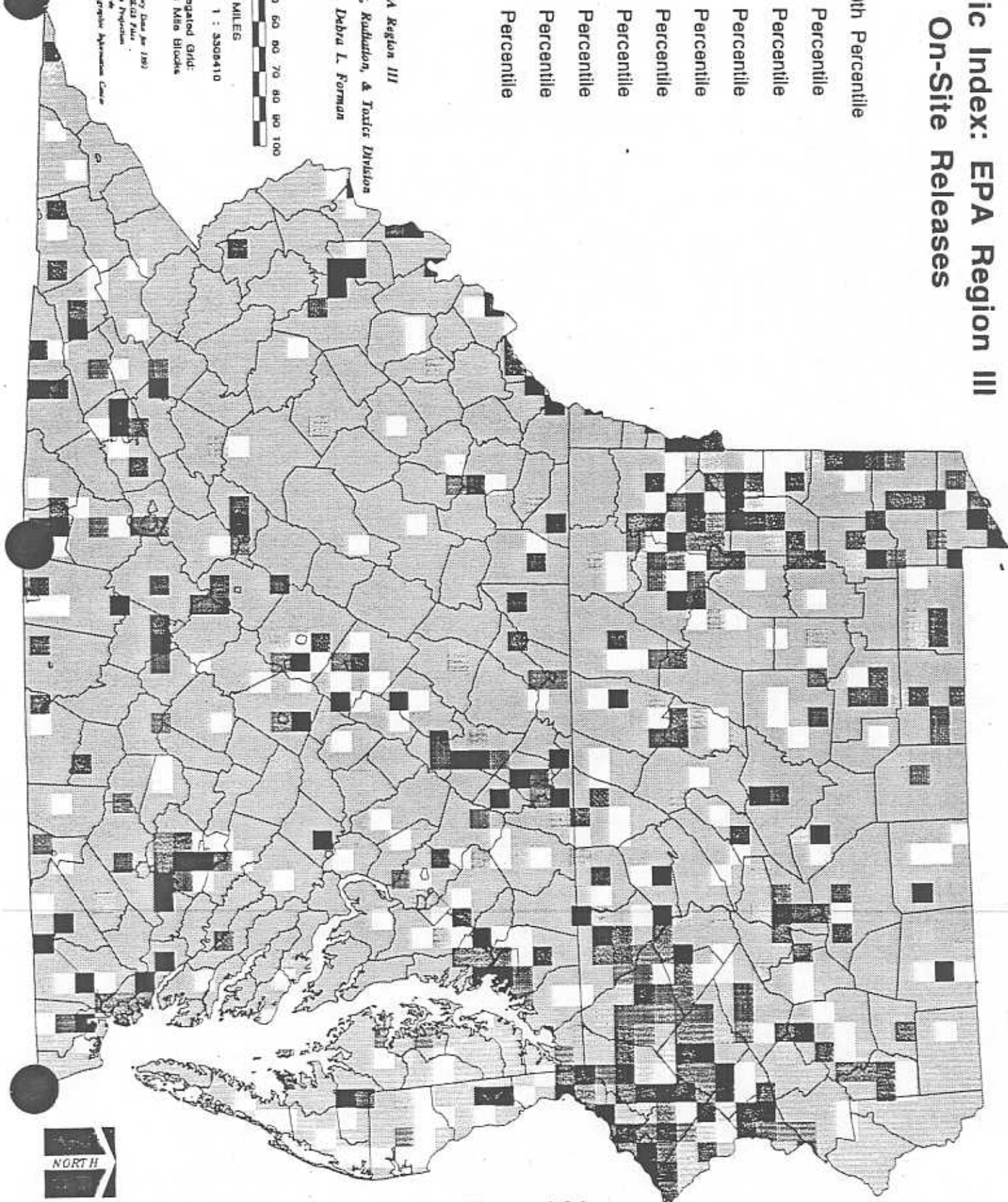
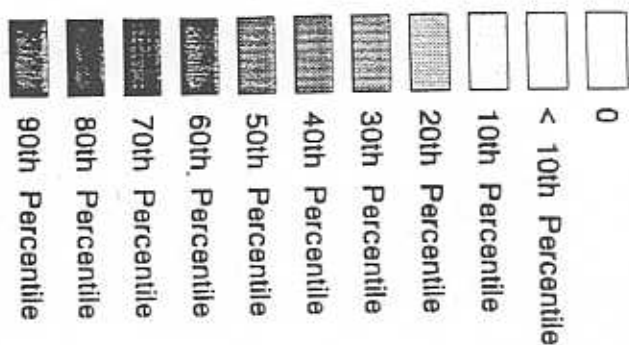


Figure 4-26

Residual Mass: EPA Region III On-Site Releases



EPA Region III
Air, Radiation, & Toxics Division
Dr. Debra L. Forman



Scale 1 : 3500410

Aggregated Grid:
6 x 6 Mile Blocks

Source: Toxic Release Inventory Data for 1991
1:100,000 USGS Digital Data
Prepared by: Louis E. Eckhardt
EPA Region III Geographic Information Center
Date: April 16, 1994

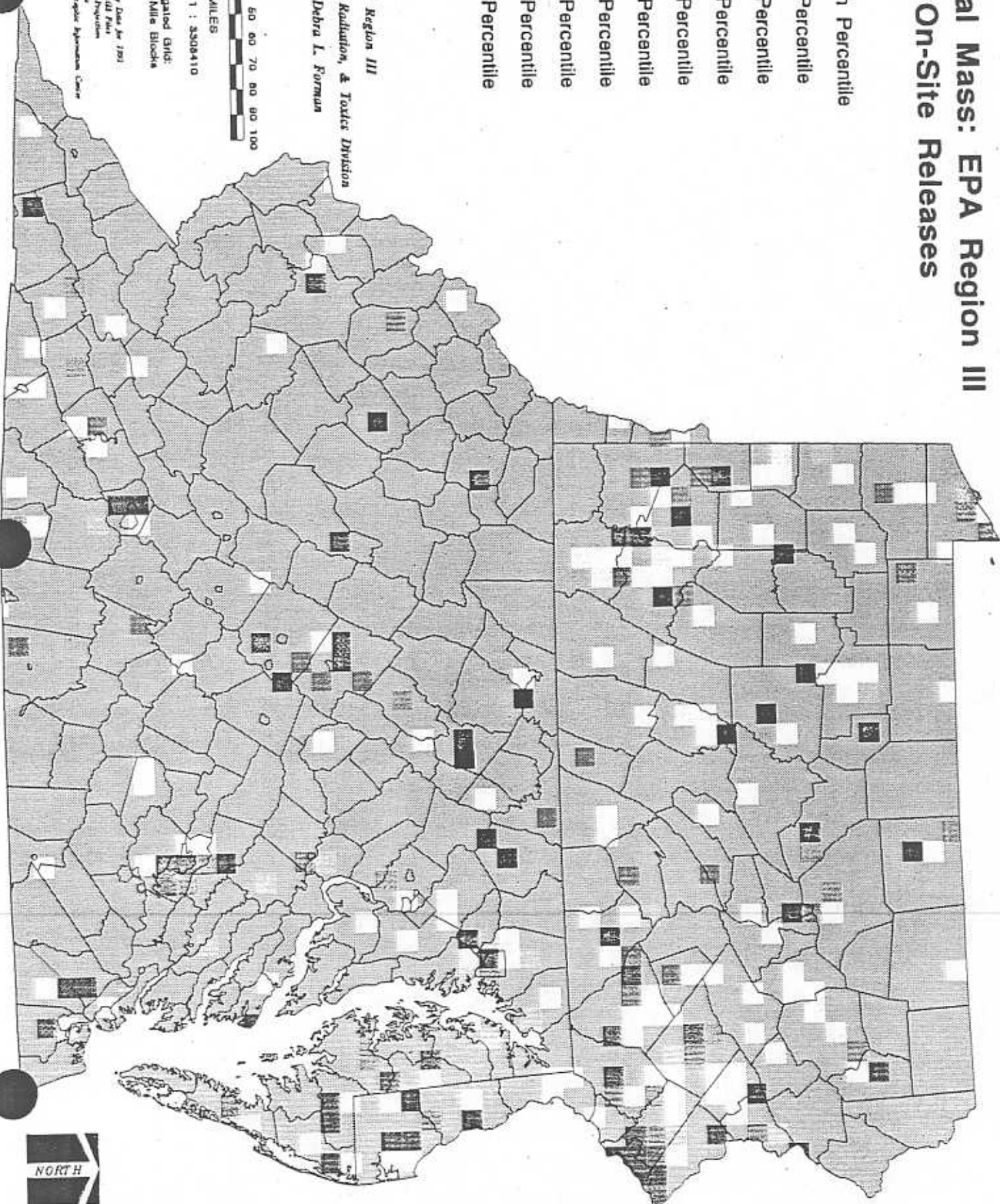
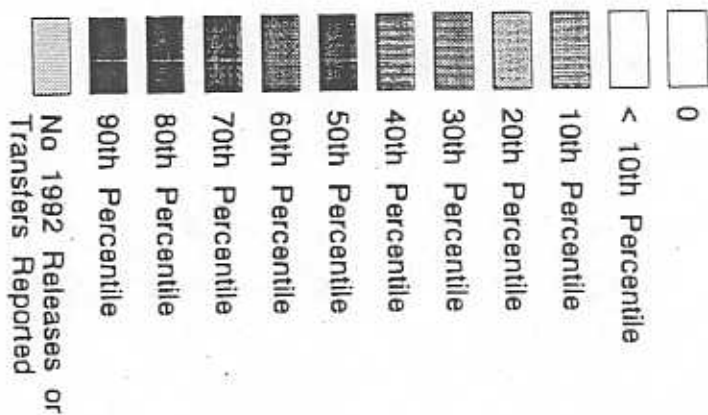


Figure 4-27

Chronic Index & Residual Mass On-Site Releases



EPA Region III
Air, Radiation, & Toxic Division
Dr. Debra L. Norman



Scale 1 : 3508410

Aggregated GHD:
8 x 8 Mile Blocks

Source: Toxic Release Inventory Data, Jan 1992
1:100,000 USGS Digital File
Regional Administrative Area Projection
Prepared by Linda S. Gable
EPA Region III Geographic Information Center
Date: April 18, 1994

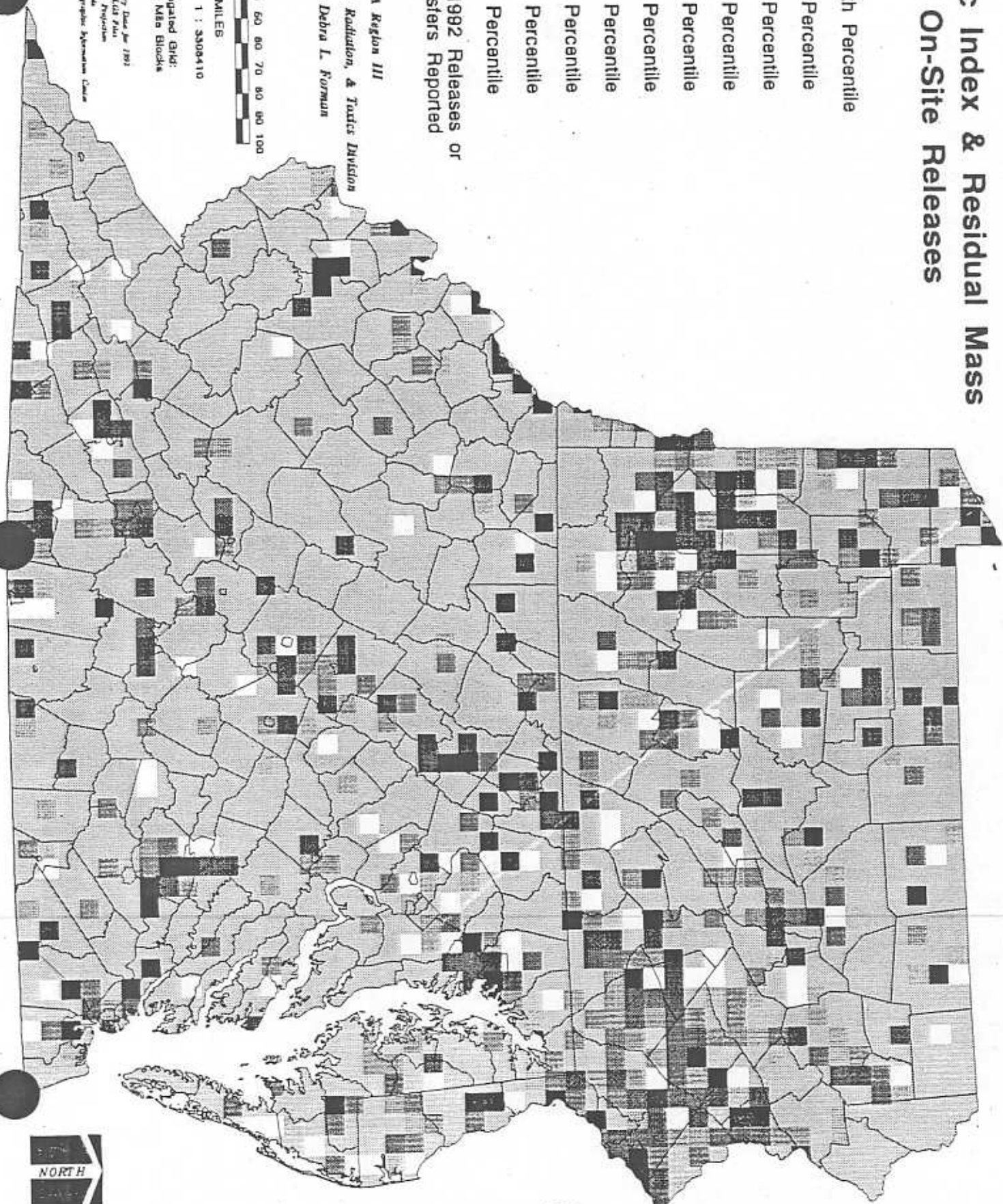


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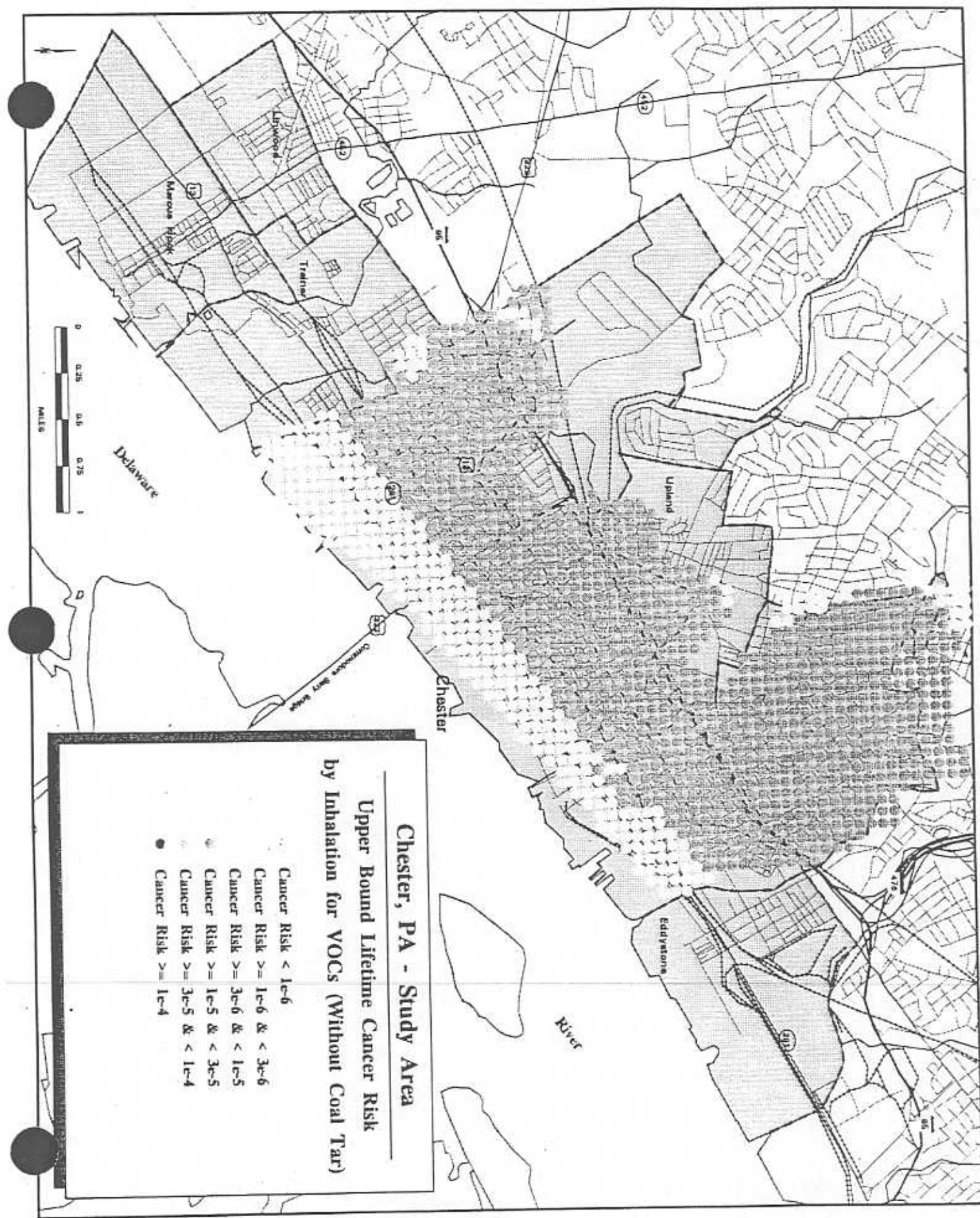


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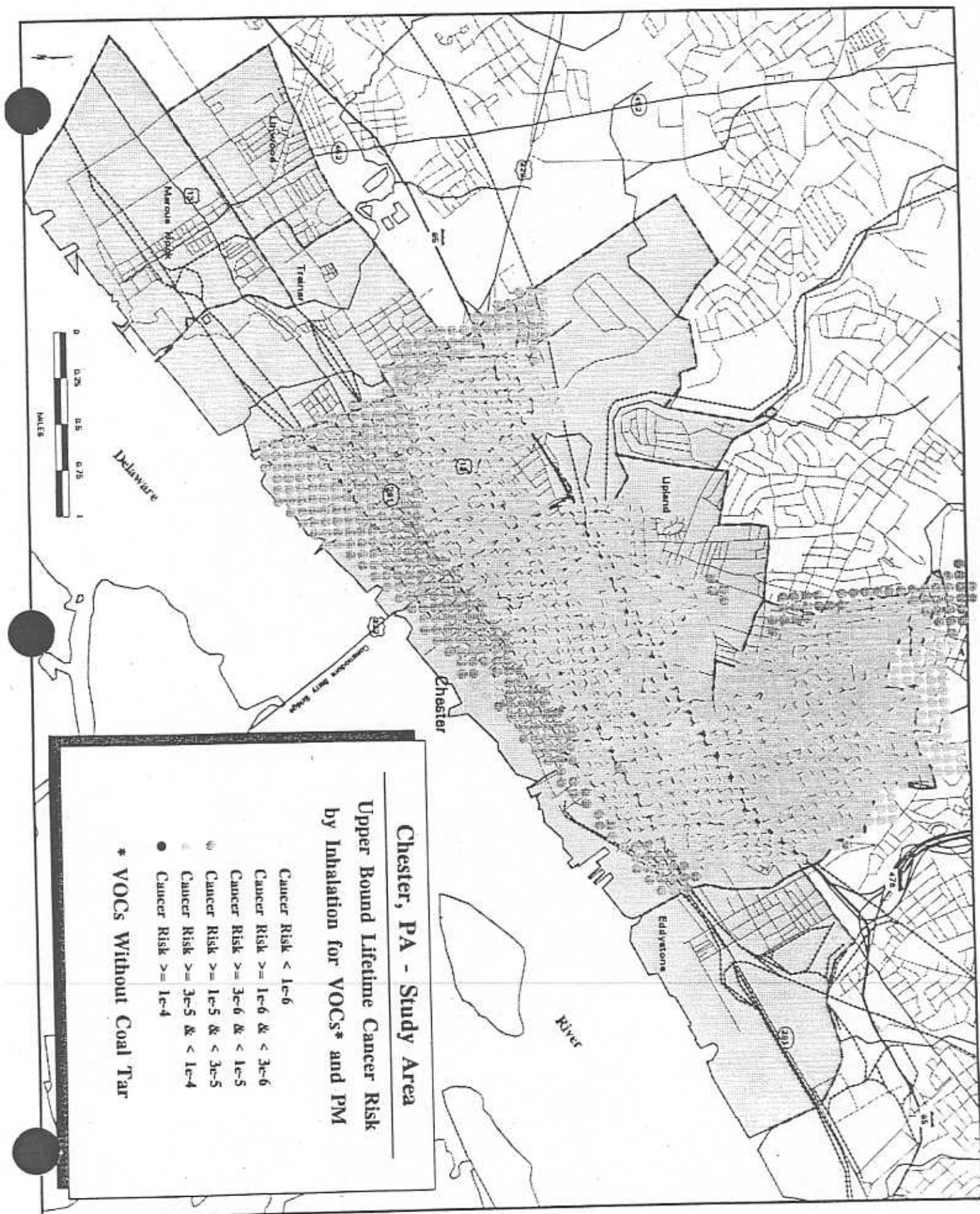


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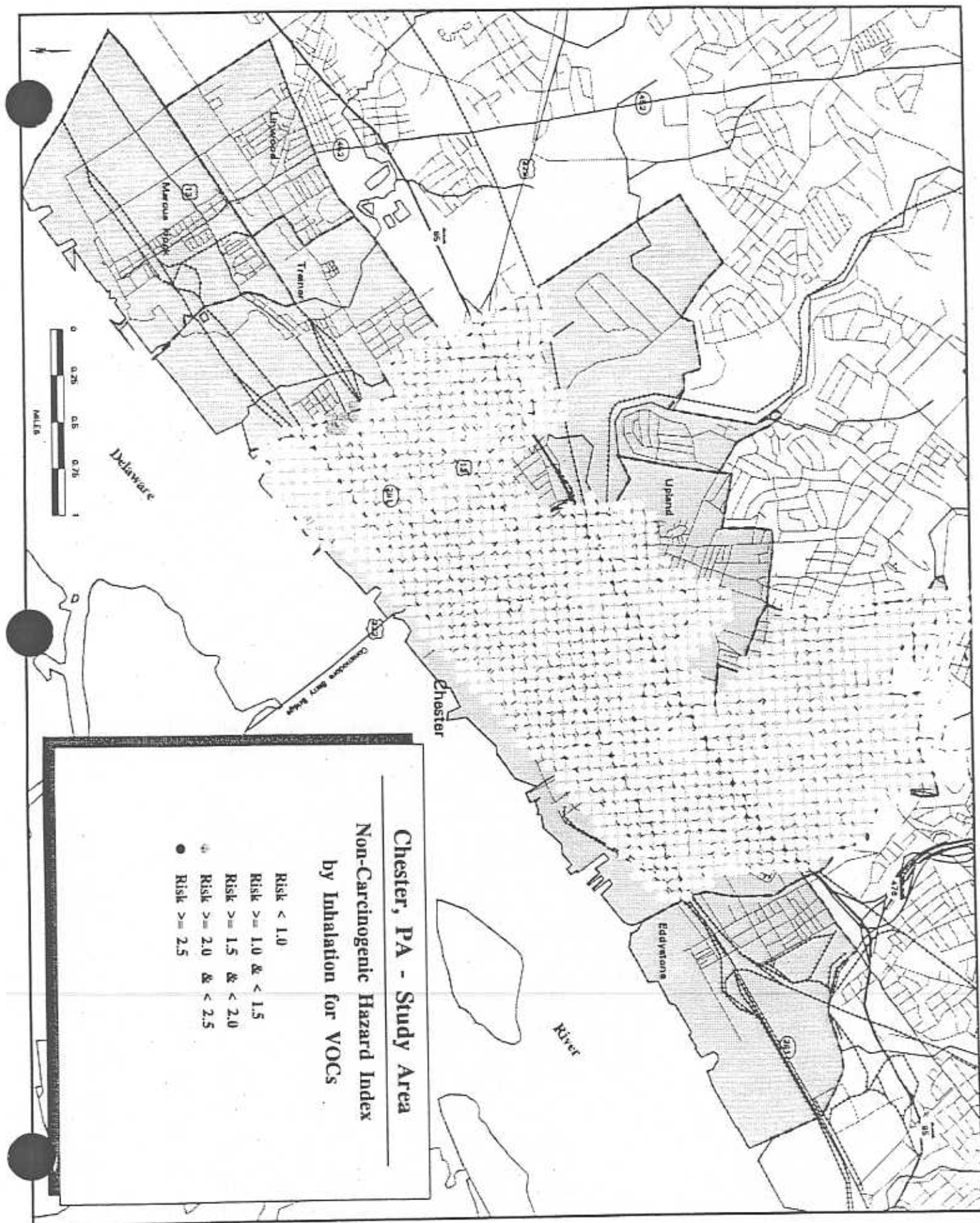


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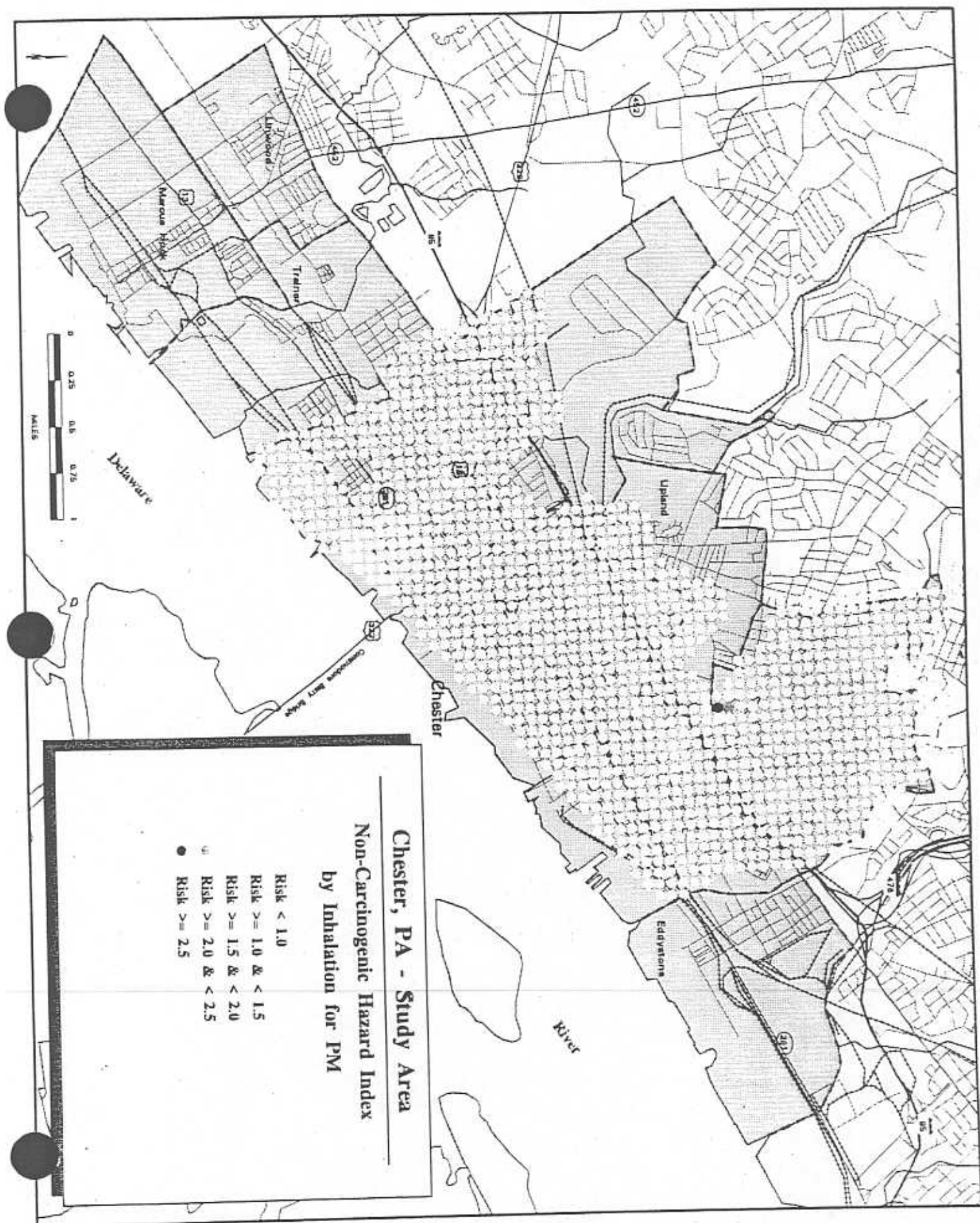


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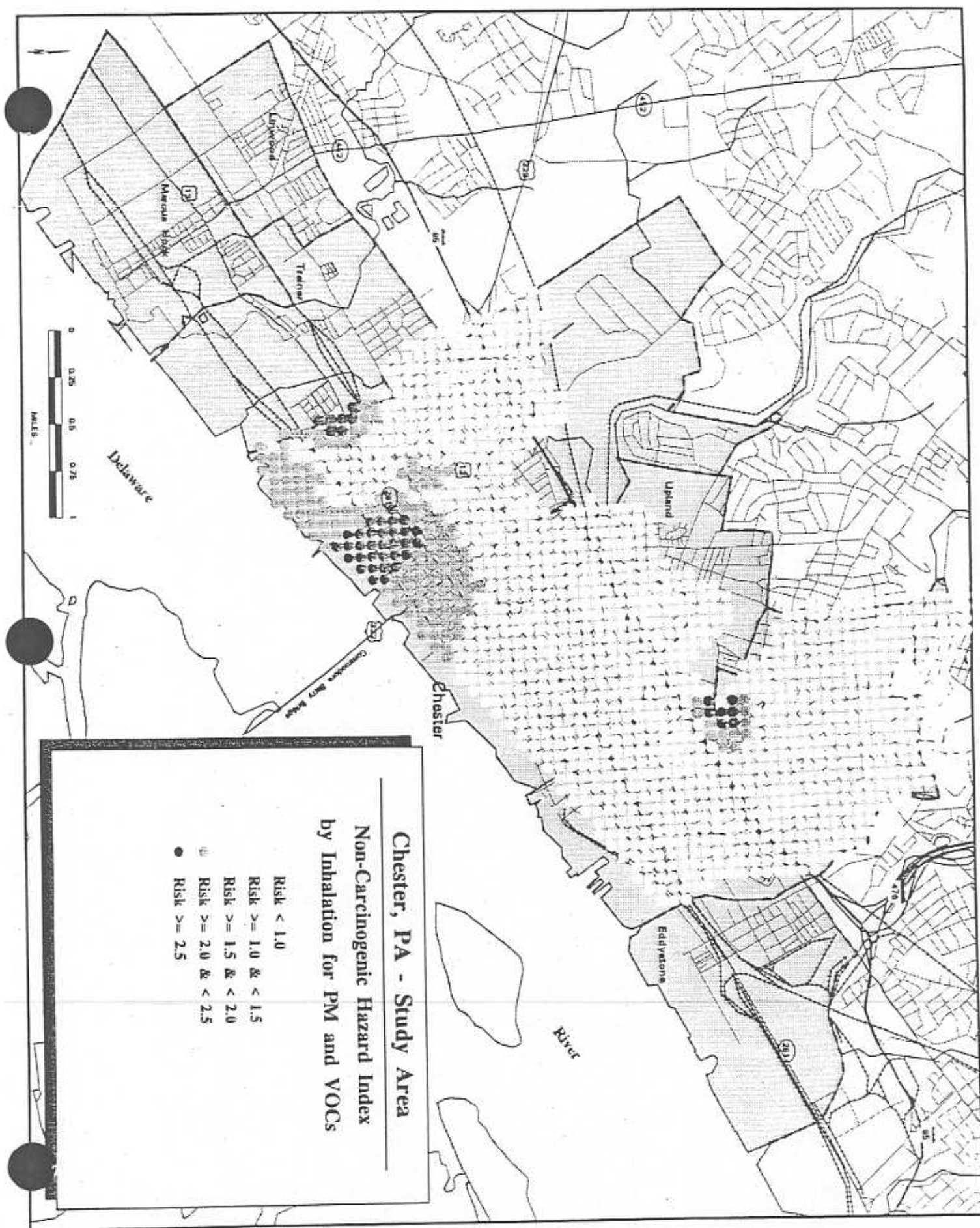


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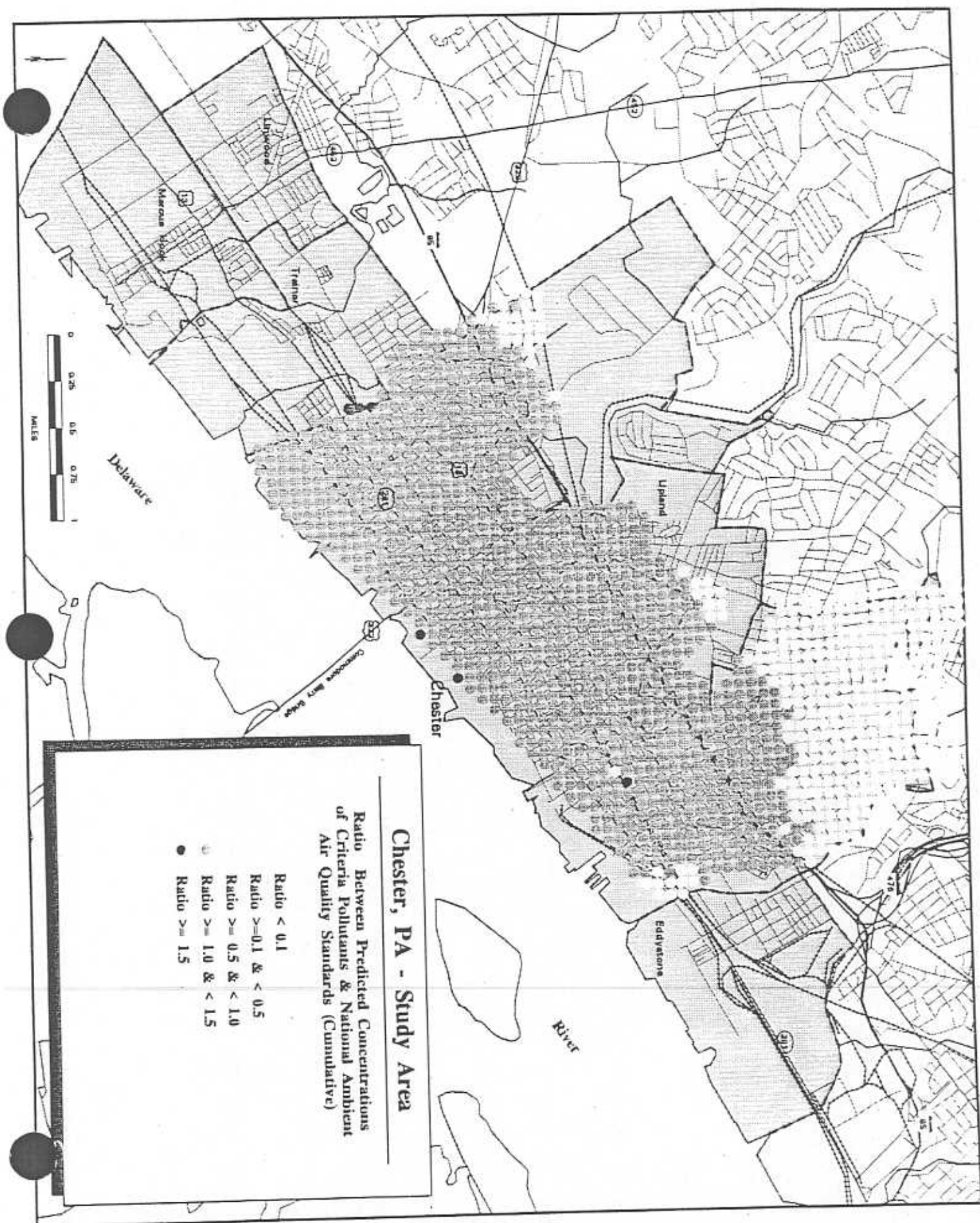


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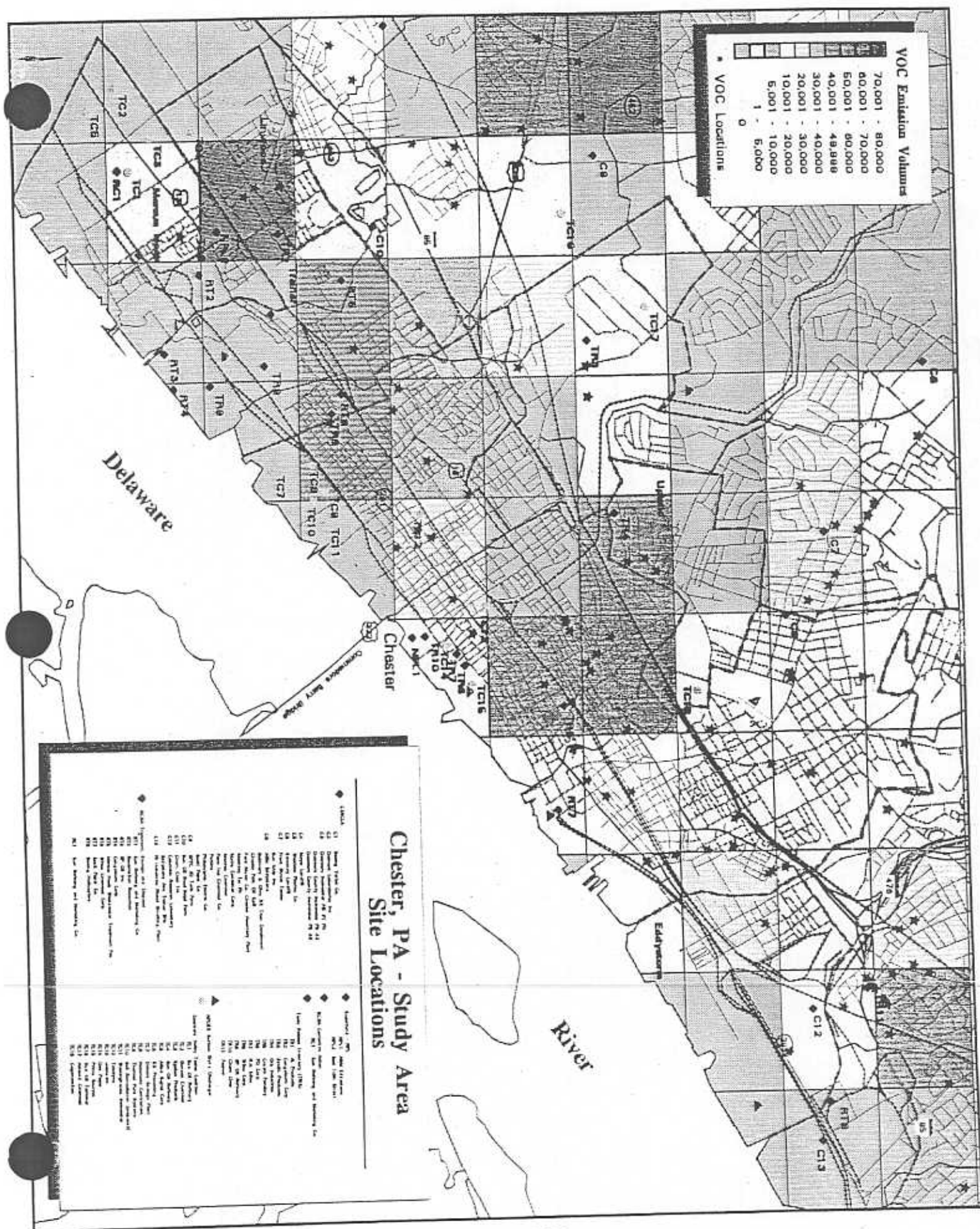


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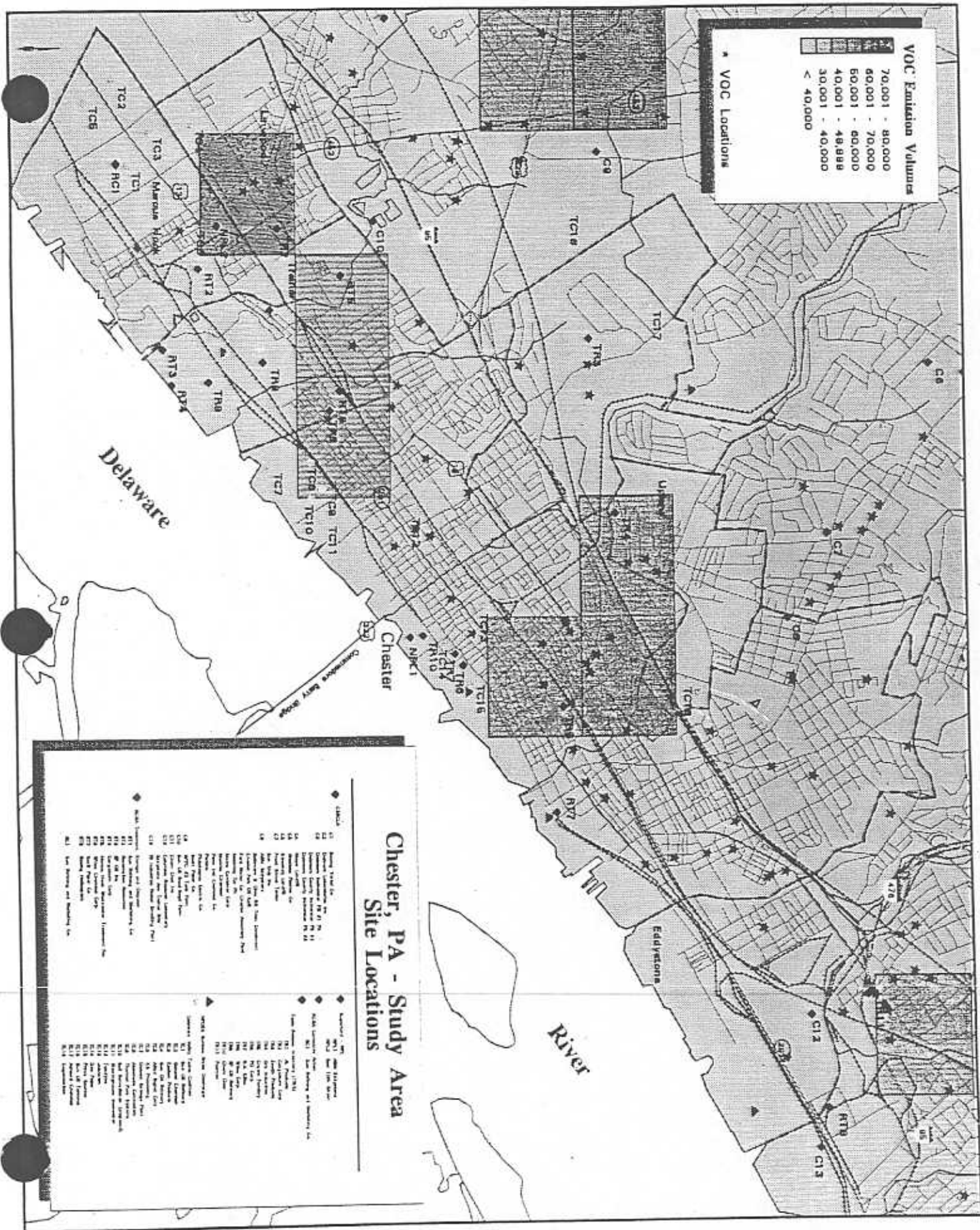


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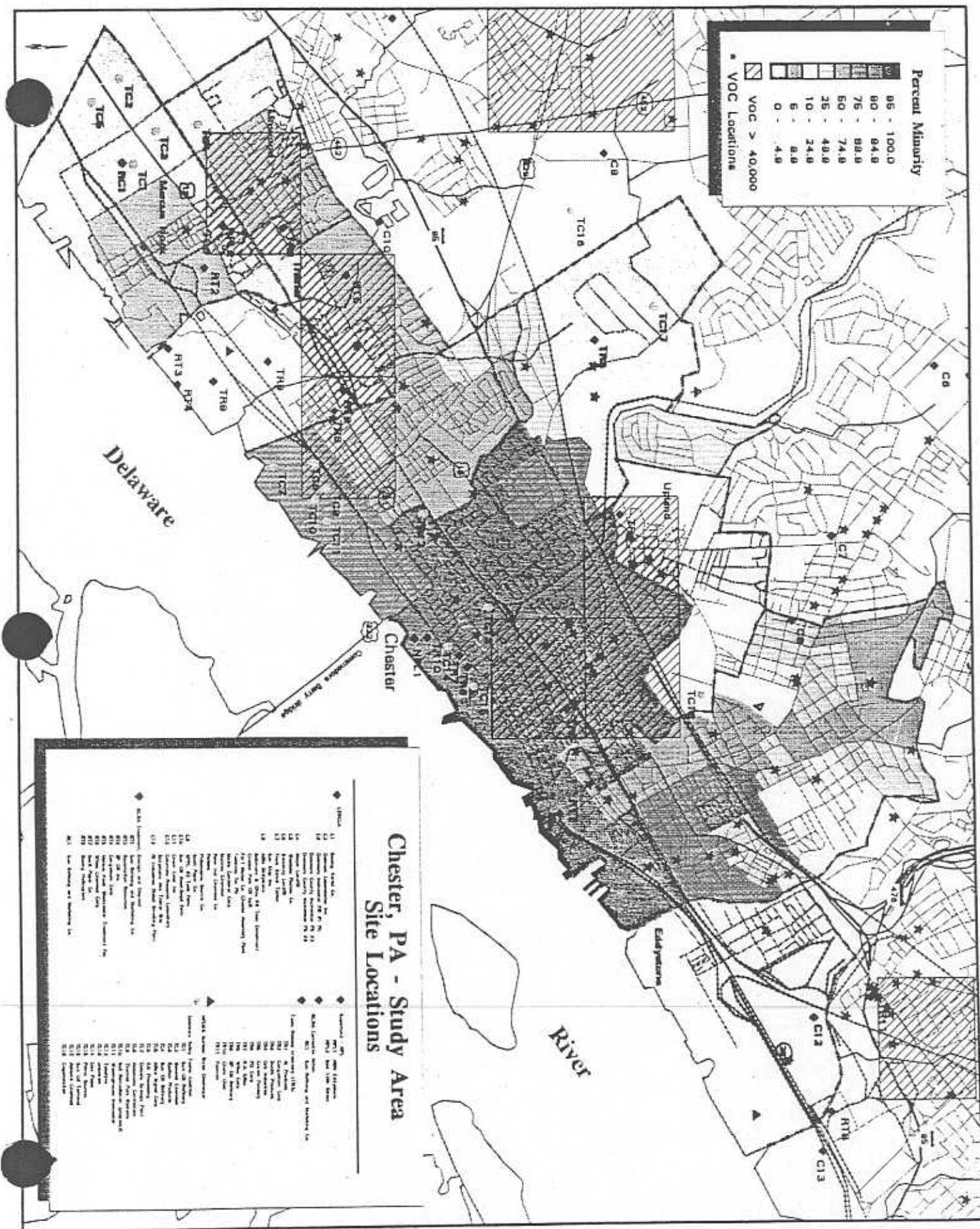


Figure 4-38